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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Twenty-eighth Annual Meeting, New England Association of Gas Engineers.

OFFICE OF THE SECRETARY, LYNN, MASS., Jan. 20, 1898.

The twenty-eighth annual meeting of the New England Association of Gas Engineers will be held at Young's Hotel, Boston, Wednesday and Thursday, February 16 and 17, 1898.

C. F. PRICHARD, Secretary.

[OFFICIAL NOTICE.]

Fifth Annual Meeting, Michigan Gas Association.

OFFICE OF THE SECRETARY, SAGINAW, E. S., MICH., Jan. 11, 1898.

To the Members of the Michigan Gas Association: Gentlemen—You are hereby reminded that the fifth annual meeting of our Association will be held on Wednesday, the 16th, and Thursday, the 17th, days of February next, at Port Huron, Mich.

The new Hotel Harrington has been selected as Association headquarters, with rates, for all rooms without bath, at $2.50 per day; with bath, at $3 per day. From experience at our recent meetings it would be well to have rooms reserved as early as possible.

The following papers will be presented for consideration:

"Experiments with the Welsbach Lamp," by Mr. Frank H. Hess.

"An Automatic Closed Purifier," by Mr. Henry G. Beatley.

"Our Patrons: How to Treat Them," by Mr. S. Milo Dole.

"The Utilization of Coal Tar by Distillation," by Mr. Edward J. Ellis.

"Reminiscences," by Mr. Robert Calhoun.

Mr. Fred. J. Howden will also present a paper, the title of which is not received. Respectfully yours, HENRY H. HYDE, Secretary.

BRIEFLY TOLD.

THE PROPOSITION TO CHANGE THE PLACE OF MEETING, WESTERN GAS ASSOCIATION.—Last week we had occasion to note there was much likelihood that the place named last year for holding this year's meeting of the Western Gas Association would be changed; and it was then said that the reasons which prompted such transference must be weighty to cause so revolutionary a procedure. Since a week the reasons have transpired, and they may not be argued against. The plain facts are: Mount Clemens was named last May as a suitable place for holding the 1898 meeting of the Association, and the naming thereof was ratified by vote of the Association. The Executive Committee of the Western, at a meeting held in Detroit, Mich., on the 11th inst., considered carefully the capacity of Mount Clemens—it is perhaps 22 miles northeast of Detroit—for the purpose designated; and, after a visit to the place, which visit was made to determine definitely whether suitable accommodations could be secured there, it was unanimously decided that such could not be obtained. Not a hotel in the Mount had a room which could seat the members during the technical part of the

proceedings; and if 150 delegates were in attendance at the meeting they would have to divide themselves into thirds, since none of the hotels could comfortably house over 50 guests. The Executive Committee wisely reported to the Board of Directors that Detroit, as a meeting place, would better answer the purposes of the Association than Mount Clemens, and it is more than likely that the Directors will by formal vote sustain that suggestion.

An International Meeting of Gas and Electric Lighting and Electric Power Representatives.—We are indebted to Mr. Thos. D. Miller, Secretary and General Manager of the Dallas (Tex.) Gas and Fuel Company, for the news that, at meeting of the Texan and Mexican interests named in the heading, the meeting having been held in Austin, Tex., on the 17th, it was definitely determined to hold a convention for mutual advancement, at Laredo, Tex., beginning March 9 and ending March 12. Mr. W. E. Holmes, Secretary of the Texas Gas and Electric Light Association, will in due time forward the precise details of the meeting, respecting headquarters, papers to be presented and nature of entertainment; and we might here remark that all these preliminaries are so well underway that those who will attend the convention are now assured their time will be well spent. Mr. Miller declares that the Mexicans, who, unfortunately for themselves, know more about losses in the electric business than they know about gains in the gas business, will have a representation at the convention of not less than 100 delegates. We hope his forecast will prove true, for gas men are always ready to show their benighted brethren the way into light out of darkness. Under the conditions of the announcement, it will be noted that the Texas Association has changed its meeting date from May to March, and that the International Convention may not conflict with the meeting of the Ohio Gas Light Association, the former assemblage has named its dates wisely and well. In due time the complete programme will be given in the Journal.

Death of Mr. George D. Cabot.—As the ripened wheat is garnered, so did Mr. George D. Cabot pass on. In the 86th year of his useful, peaceful life the veteran heard the summons that comes to all. His demise occurred at his home in Lawrence, Mass., on Tuesday, the 18th inst., and, with loving ministrations, his remains were restored to earth, on Friday, the 21st. Rather than our history of his career be ragged or incomplete, the recital of his simple, straightforward life is carried over for a week.

Death of Mr. Charles Frederick Marsh.—Mr. Charles Frederick Marsh, for over 50 years connected with the gas business in New York city, died at his home, 2 Irving Place, on the afternoon of Saturday, the 15th inst., in the 69th year of his age. The father of deceased (Mr. Thomas Marsh) was connected with the Manhattan Gas Light Company in 1836, and the son entered the service of that Company about 1845. He remained with the Company until it was merged into the Consolidated Gas Company, always holding responsible positions in both. He was a member of York Lodge, No. 197, F. and A. M., and was also a member of the St. Andrew Society. In connection with the latter membership it is said he was the only one on its rolls not of Scotch origin. He was related to the Messrs. Jardine, the noted local architects, and was also quite renowned as an unostentatious traveler to foreign countries. He is survived by three brothers.

Notes.—Secretary Forstall, of the American Gas Light Association, is to be congratulated on the speedy issue of the 14th volume of the "Proceedings of the American Gas Light Association," for a copy of which we are indebted to his attention. Further, the Secretary is to be congratulated on the excellent manner in which the volume has been compiled, and for the completeness of its typographical arrangement. ——At the annual meeting of the Laclede Gas Company, of St. Louis, Mo., a dividend of 1½ per cent. was declared on the common stock. The Directors chosen were: Emerson McMillin, Fred. Edey, Jas. Campbell, I. H. Lionberger, Geo. A. Madill, J. C. Blarcom, Jno. Scullin, P. J. Doerr and Alex. Ross; Messrs. Scullin and Doerr replace Messrs. Nicholson and Conn.——At the annual meeting of the Ypsilanti (Mich.) Gas Company the officers elected were: Directors, Mrs. H. C. Swift and Messrs. D. L. Quirk, S. H. Dodge, C. S. Wortley and C. E. King; President, D. L. Quirk; Vice-President, C. E. King; Secretary and Treasurer, C. S. Wortley.——We are indebted to Mr. Walter T. Dunn, Secretary, for a copy of the "Transactions" of the Incorporated Gas Institute (England), which copy well tells the doings of the Institute, at its 34th Annual Meeting, held at The Guildhall, Bath, last June, under the direction of President C. Stafford Ellery.

[Prepared for the Journal.]

The Balance Sheet of Heat Units in Coal Distillation.

By Mr. Herman Poole, F.C.S.

Quite frequently we hear of a boiler test, in which is reported such and such a percentage of yield, such a percentage of loss by radiation, unburnt fuel, waste gases, etc., and also a certain quantity unaccounted for. We seldom, if ever, hear of a test of coal for gas making showing the same or similar facts; yet it is quite feasible, and, in a great many cases, very desirable, that such a report should be made. By this means it is possible to ascertain more exactly what can be done with the coal, what amount of gas, tar, ammonia, coke, etc., can be obtained, and how it compares with what should be obtained; what the yield in efficiency amounts to, and at what cost of physical force or heat units.

We have reports of experimental runs in which are stated the weight of the coal used, the quantity of tar, gas, coke, etc.; but these yields are not based on the heat energy of the coal and its products. Samples of tar produced may show the same percentage yield in quantity, but in actual heat value they may differ widely. A large yield of gas may be obtained under certain conditions; but without the heat test, or a thorough analysis, no actual information can be obtained. Coke does not vary so much, still there are considerable differences between the cokes made by different methods.

To outline what can be done in this respect is the object of this article, and the subject will be treated in such a way that some idea can be had of possibilities in this direction, and the information to be expected from pursuing such a course.

Formerly the determination of heat units of a fuel combustion was a great undertaking. The apparatus was costly and frail, and required careful and expert handling; the calculations were long and tedious; the corrections longer still. At least two operators were needed, and both should be experts. As an alternative and a method of avoiding all this troublesome experimenting various methods of calculation, without using the calorimeter, were devised by different authors and used by them with varying success.

Most methods of calculating the heat units of a coal depend on a careful and thorough analysis. Here again comes up another difficulty—the analysis must be correct, or the estimate deduced from it would be wrong. Hence various simplifications and modifications of the analytical process have been put forth.

The actual facts are that we may have a faulty analysis, a faulty formula, or a wrong application of the formula, not to mention a liability to mistake in a long calculation. No wonder physicists and engineers alike, and particularly those engaged in practical, industrial life, gave up and lost all faith in coal analyses, heat determinations, and all connected with them.

To-day, however, affairs have changed. The long, difficult and tedious analysis is not needed, and no suspicious formula is wanted; but very little calculation is required, and that is quite simple. The calorimetric bomb and its modifications make the determinations quickly and accurately, and require less time to finish the test than was formerly consumed in making ready. An analysis is not required, although, at times, it may help to better understand the general properties of the coal.

If it is necessary to have a choice between the calorometric test without the analysis, or the analysis without the test, the former is far preferable, and much more to be depended on for accuracy. The great advantage, however, is in saving of time, as, by means of the modern calorimeters, minutes are used to make the test, whereas by the analysis and calculation days would be required.

The Berthelot bomb is the most accurate of the modern apparatus, but there are two others which are simpler in action and require less calculation. These are the Carpenter and the Barrus calorimeters. Both are well adapted to industrial use and for making comparative tests, although neither can be relied on for rigid accuracy, unless in expert hands. The calculations and corrections are very simple—in fact, hardly any at all—and they can be used repeatedly in succession.

The Barrus' one is the cheapest one yet made that will give approximately accurate results.

All fuels, or other substances capable of uniting with oxygen, through the phenomenon called oxidation or burning, by such union generate or liberate a certain definite quantity of energy. This energy may be manifested as heat, or it may be transformed into some other form of force, such as electricity or light. Under like conditions the same quantity of a given force is produced; under unlike conditions different quantities of a given force are made manifest, and thereby at times

cause considerable discussion. These remarks apply forcibly to the history of investigations on coal and its products.

For instance, carbon is the chief constituent of coal, and every pound of it burnt in oxygen to carbonic acid generates 14,650 units of heat. This amount of heat is produced whether the combustion be quick or slow; whether produced all in one combustion, forming carbonic acid direct, or whether it is through two combustions; first, carbonic oxide and then carbonic acid. The same amount of heat is formed whether the oxygen be pure or mixed with other gases, as in the air. In every case 14,650 heat units are produced.

Hydrogen is another element present in coal. Under similar conditions to those mentioned above, it always produces 62,100 units of heat. A similar statement can be made regarding sulphur, iron or any other element.

If, however, the carbon and hydrogen should be united before combustion as a hydrocarbon, marsh gas, CH_4, olefiant gas, C_2H_4, acetylene, C_2H_2, or any other of the innumerable similar compounds, then, apparently, the heat value of the elements would not be realized. Nevertheless, this is the case, as a certain portion of the heat units would be consumed in breaking up the combination previously existing. The same is true of sulphureted hydrogen; before it is burnt it must be decomposed.

Marsh gas, CH_4, for instance, has a percentage composition of

Carbon	75
Hydrogen	25
	100

Its theoretical value would then be

$(0.75 \times 14,650) + (0.25 \times 62,100) =$	26,415
The heat value actually obtained is	24,017
Showing a difference of	2,398

Which difference has been consumed in forming the CH_4 from C and H_4.

Olefiant gas, C_2H_4, has a percentage composition of

Carbon	85.7
Hydrogen	14.3
	100.0

The theoretical heat value on combustion would be

$(0.857 \times 14,650) + (0.143 \times 62,100) =$	21,257
The actual heat value obtained is	21,928
A difference of	671

Acetylene, C_2H_2, has a percentage composition of

Carbon	92.3
Hydrogen	7.7
	100.0

Its theoretical heat value on combustion would be

$(0.923 \times 14,650) + (0.077 \times 62,100) =$	18,304
Heat value by calorimeter	21,856
Difference	3,552

A similar difference will be found with the other hydrocarbons, and it will be seen that in each case the actual heat value obtained is greater than the theoretical value. This difference does not depend entirely on the ratio of the two elements, but also on other physical differences which need not be mentioned here. This is strikingly shown in comparing acetylene, C_2H_2, and benzene, C_6H_6. Both have the same percentage composition, but the heat value of acetylene is 3,762 units greater. Some compounds differ from those just mentioned, inasmuch as they absorb heat on being decomposed instead of liberating it; some of the iodides and acids act this way. In any case the safe and sure way is to make the test with a calorimeter.

The heat units of combustion of all ordinary compounds have been carefully determined experimentally within the last few years, and by many observers. All the results agree closely, and hence are within the limit of experimental error. These tables are published in many different works and obviate the necessity of calculating the heats of the common compounds. The heat units produced by the union with oxygen of the substances commonly occurring in coal and coal gas are given below:

	Per Pound.	Per Cubic Foot.
Hydrogen	62,100	347
Carbon to carbonic oxide	4,390	
Carbon to carbonic acid	14,650	
Carbonic oxide	4,383	342
Marsh gas, CH_4	24,017	1,128
Olefiant gas, C_2H_4	21,928	1,713
Methane, C_2H_6	22,338	1,870
Acetylene, C_2H_2	21,856	1,624
Benzene, C_6H_6	18,094	3,763
Illuminants	18,000	4,000

If we consider coal as composed of carbon, hydrogen, sulphur, ash, moisture, etc., and analyze it for these elements we obtain a certain set of figures which will give what is called an ultimate analysis. For instance, a sample of coal from Hocking Valley gives, according to that kind of analysis:

Carbon	69.41	per cent.
Hydrogen	4.60	"
Oxygen	10.33	"
Nitrogen	1.46	"
Sulphur	1.67	"
Ash	5.83	"
Moisture	6.72	"
	100.02	

There are other ways of stating the analysis, but they need not be mentioned here. Different analysts look on the coal as being made up in different ways, and try to express their ideas in the analysis. The method above is an old established one, and will answer perfectly for our purpose now.

If, however, we consider the coal as made up of the various products we obtain from it on distillation and similar treatment, we would have for its analysis:

Fixed carbon	50.32	per cent.
Volatile matter	37.13	"
Ash	5.83	"
Moisture	6.72	"
	100.00	;

or, in other terms:

Coke (50.32 + 5.83)	56.15
Gas	37.13
Water	6.72
	100.00

This last result shows what may be actually obtained from the coal when subjected to the conditions of distillation, etc., which would be analogous to those used in making the analysis. It is well known, however, by all gas makers that these proportions can be varied, and are varied considerably in the actual practice under different circumstances. A change in the rapidity of heating, in the intensity of the fire, kind and style of retort and various other influences have a decided modifying effect. In making the analysis chemists usually follow nearly the same routine and use nearly the same temperatures and times, so that their results are comparable. The gas manager knows this and makes his deductions accordingly.

Good bituminous coal yields, on complete combustion in oxygen, from 14,500 to 15,000 units of heat. If the ultimate analysis, giving the proportions of the elements as cited above, exhibited the actual composition of the coal as it exists then the heat units of these different elementary bodies added together would give the heat value of the coal; but this is not the case exactly. Why it is not is easily explained, bearing in mind what was written above about the three gases—marsh gas, olefiant gas and acetylene. Yet, for several years, in fact for many years, experimenters have been trying to obtain a formula which, based on a faulty analysis, would give correct deductions. As an example of this, the coal analyzed above gave by

Calorimetric test	12,390 heat units.
Calculation	13,823 "
Excess	1,433 "

The calorimetric test was made with the coal in its crude state—*i. e.*, with the ash and water in it. If these are deducted and only the pure coal considered the heat value becomes 14,150 units. This method is used by many engineers and physicists now as being more advantageous for comparison of different localities. All being reduced to the state of pure coal or combustible places them all are on the same level. When this coal is subjected to heat in a closed retort various products of decomposition are formed, coke, tar, etc.; and while a few of them, such as water, yield but little or no heat on burning, the majority of them are capable of yielding heat, and hence can be used for heating and illumination. If the distillation was conducted in such manner that the

actual amount of heat used could be ascertained, then this heat, added to the possible heats of combustion of the products formed by the distillation, would be equal to that produced by the combustion of the coal.

Unfortunately we cannot tell exactly how much heat has been used by the distillation. There are so many elements entering into the case that, although they could be ascertained with a fair degree of exactness, I know of no case where they have been so ascertained. The difference, however, is no greater, as will be seen later, than happens frequently with steam boiler tests made by competent engineers. At times a close approximation is possible, as will be shown in the detailed discussion to follow.

This account of a distillation is not a theoretical one, but one actually occurring, and the data given were carefully obtained and verified. The coal was analyzed and weighed. The calorimetric value of coal and products was actually obtained by experiment, and not calculated, and each product was carefully weighed as pure and clean as it could be. The analysis of the coal showed—

Carbon	75.182	per cent.
Hydrogen	5.176	"
Oxygen	8.202	"
Nitrogen	0.940	"
Ash	7.050	"
Moisture	3.450	"
	100.000	

Total heat units for the crude coal..... 13,260
" " " pure " 14,929

Upon distillation at cherry red heat there was formed—

Coke	65.66	per cent.
Tar from hydraulic main	0.87	"
" cooler	1.16	"
" condenser	1.89	"
Gas	17.09	"
Ammonia liquor	9.35	"
Loss, water, etc	3.97	"
	100.00	

These products yielded in analysis the following composition :

Analysis of Decomposition Products.

Product.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Ash.	Water.	Calorific Power.
Coke	85.77	0.41	2.04	0.62	10.27	0.88	12,635
First tar	89.91	4.95	5.14	....	.....	....	16,097
Second tar	87.22	5.50	6.28	....	.....	....	15,896
Third tar	85.18	5.60	9.22	....	.....	....	15,369
Gas	55.09	21.46	23.45	....	.....	....	20,000
Am. liquor	.....	.....	.....	....	.....	....	00,000

In the above table the analysis of the gas is given by weight, so as to have it comparable with the analyses of the other products. The specific gravity of the gas was not taken ; it had a heat value of 652 units per cubic foot. No analysis is necessary for the ammonia liquor, as it would be of no value in the present discussion.

The heat value of these different products added together should equal the total heat value of the original coal. Multiplying the percentages obtained by the respective heat values :

Heat Values of Decomposition Products.

Coke	65.66	per cent.	× 12,635 =	8,296
First tar	0.87	"	× 16,097 =	140
Second tar	1.16	"	× 15,856 =	184
Third tar	1.89	"	× 15,379 =	290
Gas	17.09	"	× 20,000 =	3,418
Loss	3.97	"	× 13,260 =	527
Total				12,855
Heat units of coal				13,260
Unaccounted for, 3.05 per cent				405

This is a much better showing than is usually obtained in steam boiler tests, in which the unaccounted-for heat units sometimes amount to 20 per cent. It shows that practically all the heat value of the original coal has been saved and may be realized from the various products.

But another item of interest comes up here. In order to split up the coal and produce these various products of the decomposition, force was needed, and as all the original force of the coal is retained, this new force must have come from outside. This is well known, and it is also evident that the outside force operating to produce the charge was obtained from the fire under the retorts.

In the case under consideration the amount of heat used for this purpose was obtained from a consumption of coke equal to 21.09 per cent. of the coal distilled, and as this coke was made from the same coal previously used, its composition and real value must have been the same as that produced. Then the amount of heat used would be 21.09 per cent. × 12,635 = 2.665 heat units, and this is 20 per cent. of the entire heat value of the coal.

These 2,665 heat units then were used in decomposing the coal, forming the new compounds, distilling them, heating them, and also in furnishing the heat lost by radiation and that carried away to the chimney by the waste gases from the fire. The amount of heat actually used for the first portion of these reactions cannot be exactly ascertained, but the losses from radiation and waste gases can be approximated. An idea as to the amount of heat used in the decomposition can be had by comparing the actual and theoretical heat units of the different compounds produced. This is shown in the subjoined table.

Comparison of Calculated and Actual Heat Values.

Products.	Calculated.	Actual.	Differences.	Percentages.	Total Differences.
Coke	12,632	12,635	3	65.66	0
First tar	15,639	16,097	458	0.87	4.1
Second tar	15,592	15,896	304	1.16	3.5
Third tar	15,150	15,369	219	1.89	4.1
Gas	19,512	20,000	488	17.09	69.5
Grand total difference					81.2

Here, then, we have accounted for only 81 units out of 2,665 ; hardly enough to mention. An investigation into the loss by radiation and chimney gases will show better.

It has been shown that in a steam boiler setting the loss of heat due to radiation amounts to about 10 per cent. With a retort setting, considering the difference of arrangement and the heat employed, the difference will not be great ; we are safe then in placing our loss at the same figures.

The quantity of coke burnt was 21.09 per cent. of the weight of the coal. Hence this was equal to 21.09 per cent. of 1 pound = 0.2109 pound, or 1,476.3 grains. Supposing 300 cubic feet of air was supplied per pound of fuel, then we should have 63.27 cubic feet of air used to burn this coke. One pound of coke used 2.67 pounds of oxygen for its combustion, and hence there would be consumed 0.5630 pound of oxygen, or 6.3 cubic feet ; but as there is no change of volume of the oxygen the gaseous volume would remain the same. The amount of hydrogen is too small to consider, so that we can call the volume of cold gases the same as the volume of air supplied. The composition of it would be changed, and instead of having

Oxygen	20.77	or, by weight,	22.90
Nitrogen	78.35	"	76.32
Aqueous vapor	0.84	"	.71
CO_2	0 04	"	.07
	100.00		100.00

it would have

Oxygen	10.23	or, by weight,	11.11
Nitrogen	74.11	"	70.96
Aqueous vapor	6.17	"	3.75
CO_2	9.49	"	14.18
	100.0		100.0

The number of heat units this gas would carry off may be computed by multiplying the percentage in weight by the specific heats and then multiplying the sum of these products by the temperature of the gases.

The specific heat of oxygen is	0.217
" " nitrogen	0.244
" " aqueous vapor	0.479
" " carbonic acid	0.217

Then—

For oxygen	.1111 × 0.217 = 0.0241
" nitrogen	.7096 × 0.244 = 0.1731
" aqueous vapor	.0375 × 0.479 = 0.0179
" carbonic oxide	.1418 × 0.217 = 0.0308
	0.2459

As the temperature is usually quite high, we may safely assume it as being at least 500° F., and the heat units carried off would be— 0.2473 × 500 = 123.65 units per pound of gases ; and as there are 5.11 pounds of air the product

123.65 × 5.11 = 632 units,

represents the amount of heat carried off by the products of combustion of one proportional charge of coke.

In addition to this is the heat carried off by the hot retort gas, which is gradually absorbed by the hydraulic main, the coolers and condensers. The amount could be ascertained by collecting the water formed and heated and taking account of its temperature. But I know of no case where this has been done.

We have so far accounted for 632 + 266 + 81 + 405 = 1384; over 50 per cent. of the 2,665 heat units from the coke used, and we can easily believe a large portion of the remainder has been carried off by the hot retort gases.

Research in this department of gas manufacture is comparatively new, and has seldom, if ever, been worked out. As with steam boiler tests it is desirable to know what yield is being had, using a certain boiler and a certain kind of coal, so in gas making it should be of interest to know just what yield is being obtained in gas, coke, tar, etc.; what the value is in heat units, and at what costs in heat units the products have been obtained. Ordinary percentage comparisons do not show the actual physical expenditure in the way that is shown by a reduction to heat units. This is the basis to which all results can be reduced, and easily so.

As mentioned, the methods of making these heat tests are now so much simplified, that this method of balancing a distillation account can be easily put in practice, and will give as much information of a practical value as is gained from the usual steam boiler tests. Any one with ordinary skill in manipulation can make a heat test, not necessarily a rigidly exact one, but one close enough for industrial use, and as close as will be arrived at in the other portion of the test.

All the results obtained will now be put in one table, so that they may be understood at a glance. It is not necessary to have all the data

Product.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Ash.	Water	B.T.U.	Percentage	Total Heat.
Coal	75.18	5.18	8.20	0.94	7.05	3.45	13,260	100.00	13,260
Coke	85.77	0.41	2.04	0.62	10.27	0.88	12,635	65.66	8,296
Tar from hyd. main	89.91	4.95	5.14	.....	.....	.....	16,097	0.87	140
" cooler	87.22	5.50	6.28	.....	.....	.....	15,896	1.16	184
" condenser	85.18	5.60	9.22	.....	.....	.....	15,369	1.89	290
Gas	55.09	21.46	23.45	.....	.....	.....	20,000	17.09	3,418
Ammonia liquor	.....	.....	.....	.....	.....	.....	.....	9.36	0
Loss, water, cyanogen, etc.	.....	.....	.....	.....	.....	.....	.....	3.97	527
								100.00	12,855
Unaccounnted for.	.....	.....	.....	.....	.....	.....	.....	.....	405

Coke used in heating (percentage, 21.09)		26.65
Consumed in decomposition	.81	
" waste gas	6.32	
" radiation	2.66	
Unaccounted for and loss in distillation	9.32	
Probable loss from hot gas, etc	7.54	
Total		26.65

included in the above table. In this case the data mentioned were all obtained and were given for completeness of discussion, which would not be required in an ordinary working test. The analysis of the coal, tar and gas was not needed, if the calorimetric determinations for the heat value were made. If on the other hand only the analyses were to be had and no heat determination, considerable difference in the result would be reached, as may be seen by comparing the figures given. This comparison also emphasizes the statement that in a choice between the calorimetric test and no analysis, or the analysis and no test, always choose the test as being easier, simpler and more correct.

[Prepared for the JOURNAL.]

Facts Versus Logic in the Distribution of Gas.

By MR. J. P. GILL.

In the JOURNAL of November 1st, 1897, there appeared a contribution by Mr. D. Coats Niven, of Calcutta, India, to the *Journal of Gas Lighting*, in reference to "The Distribution of Gas," which contained some criticisms, which *themselves* will admit of criticism. All gas managers will, without question, agree with him in his remark, "The subject of the distribution of gas is, I consider, of primary importance to a gas manager," for the reason that the profession has been of that opinion for three generations or so, a much longer period than the East India writer's years of hard study; and some of its members of the present day, if not all, evidently understand the subject more fully. Logic and hard facts do not always agree, and when such is the case, the hard facts will always prove the better of the two; of which we have an illustration in the following syllogisms:

Every horse is an animal;
sheep are not horses;
therefore, sheep are not animals.

Here is logic; but the fact is, sheep *are* animals. Or,

All vegetables grow;
an animal grows;
therefore, an animal is a vegetable.

Logic again, but not fact.

The Calcutta writer finds it refreshing to meet, among the general neglect of the subject at gas meetings, with "two papers on the subject—one in England and the other in America." "The American writer," he says, "states that the formula required for ascertaining the quantity of gas delivered is as follows:

$$Q^2 = \frac{D^5 H}{0.0000006 s L}."$$

And, "there is no doubt that the formula has the appearance of something new; but, on inspection, I find it is only an old friend in a new dress." If the Calcutta writer had read what the American writer had contributed to the AMERICAN GAS LIGHT JOURNAL in July, 1894, he would have found that the decimal .0000006 is the reciprocal of the constant number $(1,291)^2$ of the equation for finding the quantity of gas delivered, viz.:

$$\frac{1}{(1,291)^2} = \frac{1}{1,666,666.6} = .0000006$$

The formula, therefore, is not an old friend in a new dress, but an old friend in an old dress, and a very familiar one.

That the reduction of an equation or a fraction to its lowest term, a very common and useful mathematical operation, should be termed an "arithmetical manipulation, which may be called 'cuteness,'" is, to say the least, a remarkable opinion, which may well defy the power of logic to reconcile it with fact. If the Calcutta writer would look into a number of gas engineers' handbooks, of which there are several before the present writer, and in various mathematical works, he will find that in the tables of squares, square roots, cubes and cube roots of numbers, there is a column of reciprocals of the numbers. Are these reciprocals published because they are not fit for practical work? Not at all, for they are frequently of use in simplifying and shortening calculations. Let us see: Suppose it be required to find the quantity of gas delivered by a 6-inch pipe, s being 1 in., H, 1 in.; and L, 1,000 yards. The formula is—

$$Q^2 = (1,291)^2 \frac{D^5 H}{s L} = (1,291)^2 \frac{D^5}{L} = (1,291)^2 \frac{6^5}{1,000}.$$

The handbooks give $(1,291)^2 = 1,666,666.6$, and $6^5 = 7,776$. Now,

1,666,666.6
7776

100000000
1166666666
11666666666
116666666666

12,960,000,000.0

Requiring the use of 66 figures and a long multiplication and addition.

The use of the reciprocal, dividing to 7 places of decimals, gives $\frac{6)7,776}{12,960,000,000}$, in which calculation there are only 16 figures and a short division, without any addition.

If the diameter of the pipe were 16 inches, the fifth power of which, by the table, is 1,048,576, there would be seven multiplying figures, one in this instance being 0, requiring the use of 96 figures and a tedious multiplication and addition, the answer being 1,747,626,666,666. The reciprocal gives, $\frac{6)1,048,576}{1,747,626,666,666}$, requiring only 21 figures and a short division by 6. If the constant number were any other than 1,291, the square of that other number would be the multiplicand in the above example.

It is apparent that logic cannot figure out that multiplying by from four to nine figures, as the case may be, is as simple and expeditious as dividing by 6.

The man of facts in the West extends a friendly hand to the man of logic in the East, and hopes that there may be no greater difference between them than the above, the difference under the conditions being easily accounted for.

In regard to the English writer he, undoubtedly, is abundantly able to take care of his own side of the question, and perhaps has already exercised his privilege of doing so. There is, however, one item that it may be well to refer to. The Calcutta writer says the English essayist says as follows:

"With reference to the replacing of one main by another of larger diameter, a fallacy exists in some quarters" (it will be noticed that the reading is *some* quarters) "that the supplying capacities of the mains vary as the squares of the diameters. As a matter of fact, the capacity is as the square root of the fifth power of the diameter," that is, as $\sqrt{D^5}$ is to $\sqrt{d^5}$.

Educated and well read gas engineers are, of course, familiar with the correct formula. But it must also be considered that there are many practical men, reliable and efficient in their sphere, and entitled to respect, who, however, are not well read, and in fact would not understand a mathematical formula if they saw one, or would with difficulty and tedious attention grasp and use it.

Surely it is not amiss to let such know the difference in these terms, by a way attractive to them and which might come under their notice. A gas journal would thus be fulfilling its high duty as an educator. Of course, the formula is not new, except to those who may not have become sufficiently well acquainted with it. The words "conceited impertinence" are uncalled for and had better been omitted. How shall *they* be characterized?

In this connection, it is well to recall the fact that the squares, cubes, 4th and 5th powers, and the square roots, cube roots, etc., are given in the table, or it is shown how they can be obtained from the table, if the given number is not therein. There is, therefore, no calculation to be made, except in multiplying or dividing by figures taken from the book. We will take the illustration given in his article in an amended shape, it being remembered that the square root of the square of a number is the number itself.

The 5th powers of 12 and 14 and the square roots of these powers are given in the tables, the roots being 498 and 733; $733 \div 498 = 1.47$, a very easy calculation. Now the old formula $d^2 \sqrt{d}$ makes the following calculations necessary: $12^2 = 144$, and the square root of 12 (by the table) is 3.46. The calculation to be made is $144 \times 3.46 = 498$. The square of 14 is 196 and the square root of 14 is 3.74, and $196 \times 3.74 = 733$, and $733 \div 498 = 1.47$, as above. Here, while we have the same division there are two multiplications more in what the Calcutta writer calls the old formula than in what he calls the new formula, although both are old. Most people would prefer the so-called new method, the calculation being less complicated. It is thus not apparent that the English essayist would need a clerk to make his calculations, but rather the contrary.

What a gas manager really requires is an intimate acquaintance with, and mastery of all the details of the business, united with strong and vigorous common sense. Having these, he may profitably add to them a knowledge of science and logic *ad libitum*, if he so chooses and has the requisite time at command.

The Explosion of an Acetylene Gas Plant in the Federal Building, Wilmington, Del.

[By Lieut.-Col. W. A. Jones, Engineering Corps, U.S.A., in *Engineering Record.*]

The advent of a new illuminant and fuel gas which can be made from a simple combination of two such common materials as carbon and limestone through the agency of water power is a matter of such great moment to the public welfare that I feel called upon to announce the result of my examination of a recent accident, with some inferences as to its cause.

On December 17, 1897, a little before dark, the acetylene gas plant in the basement of the Post Office Building, Wilmington, Del., exploded with great force, killing Mr. John J. Cooper, the elevator man, who was at the time engaged in charging the generator with calcium carbide. There were two explosions in quick succession. The plant comprised a generator tank and two storage tanks, the two latter being freely connected, and one of them, which will be designated as No. 1, was connected with the generator by a pipe with a cut-off valve. This pipe also carried a safety valve. The cut-off valve operated automatically to cut off gas from the generator whenever the two gasholders were full. The safety valve acted in practically the same way, discharging into the street through the basement window whenever the gasholder of the generator should be full. The plant was of the Blanchard type, and is shown with one gasholder in Fig. 1. *A* is the generator, *B* the gasholder; 1 is the top to the charging cylinder 2, held in place by a clamp. The bottom of this cylinder is closed by a slide valve operated from the front, where pipe 5 for sluicing out the water and lime from the tank is controlled by a slide gate of lever pattern. This pipe discharges into the sewer.

The operation of charging with carbide is as follows: Close the valve connection between the generator and gasholder; open the slide gate in 5. This will draw off the water and lime sediment from the generator. Close the slide valve 3, then open the top 1 of the hand hole cylinder and introduce the charge. Then close 1 and open 3, letting the carbide drop into the metal basket which is suspended from and near the top of the gasholder tank of the generator. Then close the slide valve 3; then close the slide valve in 5, and make sure that 1 and 3 are closed and communication with gasholder is open. Finally let water into the generator, watching the gauge so as to stop at the proper moment, when the generator is nearly full. As soon as this water rises up into contact with the carbide in the basket, gas is rapidly evolved, and flows over into the gasholder, the valve in the connecting pipe having been opened. If gas is evolved faster than it will flow away, the gasholder of *A* rises and carries the carbide basket above the water and the generation of gas ceases. If more gas should be generated than the gasholder *B* and that of the generator *A* together will hold, the automatic valves operate to let the surplus off through the safety valve.

Referring to the scale drawing, Fig. 2, the facts gathered and observed by me are as follows. They relate to the status immediately following the explosion:

1. The slide valve 3 was wide open.
2. The slide gate in the sluicing pipe at the bottom of generator was only partly open, and the globe valve at the sewer connection was wide open.
3. The floor all around the generator was flooded with water.
4. The cap to the charging cylinder or handhole was off. The clamp was lying at *A* on the steps used for mounting to the charging hole. The washer, a disk of rubber cloth, was lying on top of the generator alongside the handhole at *B*. The iron cover, smeared with blood, was lying at *C* on gasholder No. 2.
5. Gasholder No. 1 was intact, but gasholder No. 2 and the gasholder of the generator were burst, as shown on the sketch. The parting was along the junction between the caps and the cylinders.
6. The charging handhole was wide open and slightly damaged.
7. The generator was also burst at the bottom at the sluice pipe connection.
8. The bottom step of the steps was broken at *D;* split off in front, and the split portion broken nearly in two.
9. The chain to the safety valve was broken.
10. A rod extended from the carbide basket up through the hole in the gasholder cover, fitting loosely therein. Gas could ordinarily leak through this joint, and also through that of the slide valve to the handhole. This would seem to account for the bad odor of gas always present in the vicinity of the gas plant.
11. The men who operated the plant were in the habit of emptying the water from the generator before introducing a fresh charge of carbide.
12. There was a lighted gas jet at *E*, and a going furnace at *F*. This jet was lighted after the first explosion, but went out after the second.
13. There was an iron column at *G*.
14. The room was ordinarily so tainted with the odor of gas that several windows had to be kept continuously open.
15. The man was found lying on the floor, as indicated on the sketch. The top of his head was blown partly off, his face completely crushed in, and his right arm and shoulder very badly crushed.

Inferences.—The explosion blew the iron lid of the charging handhole against the man's head while he was standing on the steps, staining it with blood. It then glanced and fell on top of gasholder No. 2.

Let me assemble the main facts again: Immediately after the explosion the clamp was lying on the steps. The rubber washer for the metal cap of the handhole was lying on top of the generator close by the handhole. The metal cap piece, stained with blood, was lying on gasholder No. 2, 10 feet distant. The bottom step was broken, split off in front and the split portion broken. It was about $\frac{1}{4}$-inch thick. The slide valve was wide open; the waste gate at bottom was only partially open.

Now, the iron cap, at the instant of the explosion, must have been where the explosive force would throw it against the man's head. It must either have been on top of the handhole, or in his hand close by and above the handhole, or on the handhole with his hand on it, and his head nearby and above. He must have been standing on the steps.

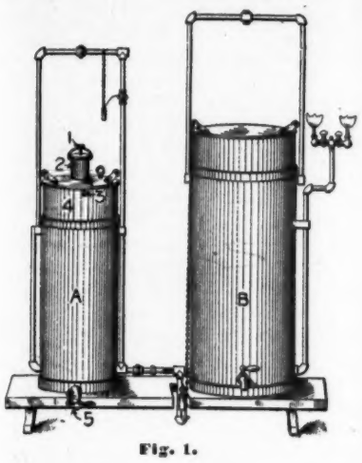

Fig. 1.

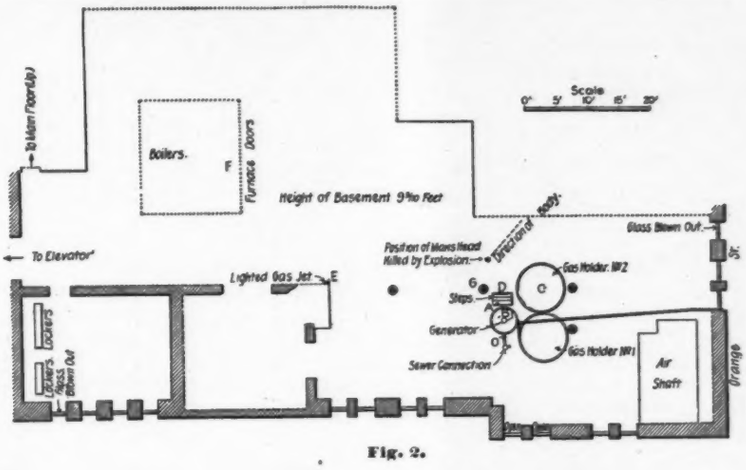

Fig. 2.

If he had been trying to look into the generator through the handhole by the aid of a lighted match, and had uncovered it for that purpose, he would first have taken off the clamp, laid it down, then the cap and laid it down, and then the washer; or he might have taken cap and washer off together, but in that event both would have been blown away from the generator by the explosion. So from such a point of view the washer could hardly have been lying on the generator, although there is a possibility of it. A reasonable presumption is that prior to charging he opened the sluice gate, but not sufficiently, expecting to draw all the water from the generator. He then proceeded to charge the generator by putting a charge of carbide in the handhole. That either from carelessness or with the supposition that no water being in the generator no gas would form when it dropped into the basket, he did not close the top of the handhole with its cap and clamp, but got down and went around to the front at *O*, where it was necessary to stand to operate the slide valve, and pulled it out, letting the charge down into the basket. That the water had not settled below the basket, on account of the sluiceway not being sufficiently open, or perhaps from being clogged. That instantly an immense volume of gas commenced pouring through the handhole. That in his excitement he forgot to close the slide valve, and made a great rush to close the top of the handhole, jumping upon the front edge of the bottom step so violently as to break it. That he seized the cap piece and clapped it upon the handhole, or was in the act of doing so at the instant when the escaping gas reached the naked gas jet, exploding the whole mass of gas simultaneously, including that which was in the generator. That the shock of the explosion threw the lid against his head and upon the adjacent gasholder, and threw him first against the iron column, crushing his side, and then upon the floor. That the shock of the explosion opened a small seam at the junction between the cylinder and top of gasholder No. 2, causing the second and milder explosion.

The facts are conclusive that at the instant of explosion the communication between the generator and a room which contained a lighted gas jet and a going furnace was wide open. In such a conjunction, whether a fresh charge of carbide had been introduced or not, an explosion was a matter of reasonable certainty. Any combustible gas would have exploded under the circumstances. But the fact that the great body and force of the explosion were at the generator is conclusive that the greatest volume of gas was there, and it must have proceeded from a fresh charge of carbide.

Adequate Ventilation in Mines--The Amount of Air Needed for Men, Horses and Lights, under Various Conditions, etc.

In a very complete paper on the subject of "Adequate Ventilation of Mines," read by Mr. E. W. Thirkell, before the Midland (England) Institute of Mining, Civil and Mechanical Engineers, the author said:

(*a*) *Respiration of Men.*—The respirations of healthy persons from 25 to 30 years of age average 16 per minute. The act of inspiration occupies longer than that of respiration in the ratio of 12 to 10 in adult males. The quantity of air which the lungs take in at each inspiration is on an average 34 cubic inches when the person is at rest. So that (34 cubic inches × 16, or) 544 cubic inches of air are required per minute. Dr. J. S. Haldane, in his report, states that "100 cubic feet of air would suffice to keep a man alive for 10 hours." This volume is only at the rate of 288 cubic inches per minute, so that the air would be breathed twice over (544 ÷ 288). Frof. F. Clowes states that "the same air might be breathed in again and again three or four times before it became inconvenient or uncomfortable to breathe."

In breathing, about 4 per cent. of carbon dioxide is given off from the lungs, consequently a person would exhale (4 per cent. of 544 cubic inches, or) 21 76 cubic inches per minute. Ordinary air contains 0.04 per cent. of carbon dioxide, so that a man vitiates it to the extent of (21.76 cubic inches ÷ 0.04, or) 544 cubic inches; consequently 544 cubic inches of fresh air will be required to purify that vitiated, in addition to the 544 cubic inches required for breathing, or (544 + 544, or) 1,088 cubic inches per minute for ordinary breathing; but the atmosphere is also made unhealthy by the poisonous addition of effete or refuse material which is being constantly exhaled from the lungs and skin of men and horses—especially when hard at work. The impurity of the air varies according to the space per individual, and it is not desirable to have many men and horses working close together. Each adult requires about 1,000 cubic feet of space for healthy breathing.

In order to arrive at an estimate of the extra quantity of air required when the men and horses are working, the following figures have been adopted, in the absence of more reliable information:

If the air inspired in a lying position be taken as unity, then the air inspired in a sitting position may be taken at 1.18; when walking 1 mile an hour, at 1.9; 3 miles an hour, at 3.22; and 6 miles an hour, at 7. Walking at the rate of 1 mile an hour is equal to 17½ foot tons of energy, and at 4 miles an hour, to 70 foot tons; a man's ordinary work is equal to 300 foot tons, and very hard work to 403 foot tons. So that lying down being taken as unity, an ordinary day's work would be equal to about 32, and as a person at rest requires 1,088 cubic inches of fresh air per minute, he would require (1,088 cubic inches × 32, or) 34,816 cubic inches, or about 20 cubic feet per minute when working.

(*b*) *Respiration of Horses.*—An average horse respires 12 times a minute (when at rest), and about 250 cubic inches will be expired at each respiration, of which 4.7 per cent. will be carbon dioxide. A horse at rest, therefore, requires (12 × 250 cubic inches, or) 3,000 cubic inches per minute for breathing, and of this 4.7 per cent. is carbon dioxide, or 141 cubic inches is converted into carbon dioxide, and it will require (141 cubic inches ÷ 0.04, or) 3,525 cubic inches per minute to purify it; a horse, therefore, requires 3,000 cubic inches for breathing, and 3,525 cubic inches in addition to purify that breathed, making 6,525 cubic inches of air per minute altogether.

Mine horses and ponies are generally much smaller than those employed on the surface, and for the purpose of this paper it will be desirable to deduct 25 per cent. from the above results; leaving 4,894 inches of air required for a mine horse when at rest and (4,894 cubic inches × 2, or) 156,608 cubic inches, or say 90 cubic feet of air per minute when working.

(*c*) *Combustion of Lamps.*—In an experiment, a safety lamp, inclosed in an air-tight vessel of 489 cubic inches capacity, used the air in 3 minutes, or at the rate of 163 cubic inches per minute. One-fifth of the air would be used up in burning, so that (163 cubic inches ÷ 5, or) 32.6 cubic inches of air would be used per minute. Then (163 + 32.6, or) 195.6 cubic inches would be required per minute, of which 3 per cent. would be carbon dioxide, or (195.6 cubic inches × 3 per cent., or) 5.868 cubic inches, and to restore the air thus vitiated to its normal state would require (5.868 cubic inches ÷ 0.04, or) 146.7 cubic inches;

and (195.6 + 146.7, or) 342.3 cubic inches of fresh air per minute. The air vitiated, however, depends upon the quality of oil used, as some oils (benzolene) require a smaller volume of air to produce perfect combustion than others (rape oil).

It has thus been shown that a man at work requires 20 cubic feet, a horse at work 90 cubic feet, and a lamp 342.3 cubic inches (¼ cubic foot) of fresh air per minute, for ordinary purposes.

Gases.—It is necessary now to consider what quantity of air, in addition to the above, is required in respect of the gases met with in the mine.

Table I.

Percentage of Carbon Dioxide Present.	Effects on Man.	Effects on Lights.
3.5	Breathing deeper.....	Still burns.
6.0	Marked Panting.....	Still burns.
10.0	Severe distress.....	Still burns.
15.0	Partial loss of consciousness.....	Extinguished.
25.0	Final death.....	Extinguished.

Table II.

Percentage of Oxygen Present.	Percentage of Nitrogen Present.	Effects on Man.	Effects on Lights.
17.3	82.7	Nil	Extinguished.
12.0	88.0	Breathing slightly deeper	Extinguished.
9.0	91.0	Breathing deeper and more frequent. Face bluish.	Extinguished.
5.0	95.0	Loss of consciousness and final death.....	Extinguished.
0.0	100.0	Death, with convulsions.	Extinguished.

Table III.

Pct. of Black-damp, (containing 87 p. ct. of Nitrogen and 13 p. ct. of Carbon Dioxide) present.	Effects on Man.	Effects on Lights.
16	Nil.....	Extinguished.
28	Breathing slightly deeper..	Extinguished.
50	Severe panting	Extinguished.
66	Life endangered.....	Extinguished.

Table IV.

Percentage of Firedamp Present.	Effects on Man.	Effects on Lights.
1.0	Nil.....	First indication of a cap.
2.0	Nil.....	Well-formed cap.
5.5	Nil.....	Lamp fires and goes out.
45.0	Breathing slightly deeper...	Lamp fires and goes out.
70.0	Life endangered.	

Sulphureted Hydrogen.—It occasionally happens that fire damp is mixed with traces of sulphureted hydrogen. This is easily recognized by the smell of rotten eggs. Sulphureted hydrogen is excessively poisonous; as little as 0.1 per cent. will cause rapid loss of conscious ness and death. Smarting of the eyes and catching of the breath are signs of imminent danger from this gas.

This gas is generated by the putrefaction of animal matters; also by the de-oxidation of sulphates in presence of decaying organic matter; it is a product of the explosion of gunpowder, and of the decomposition of iron pyrites; it also is found in old workings with standing water.

Table V.

Pct. of Carbon Monoxide Present.	Effects on Man.	Effects on Lights.
0.05	After ½ hour or more, slight giddiness on exertion..	—
0.10	After ½ hour or more, inability to walk	—
0.20	After ½ hour or more, loss of consciousness, and perhaps final death.....	—
1.00	After a few minutes, loss of consciousness and final death	Cap.

Afterdamp.—After explosion, the hot afterdamp would consist of:

Nitrogen	70.71	71.55
Argon	0.85	
Carbonic acid		9.50
Aqueous vaoor		18.95
		100.00

Table VI.

Pct. of Afterdamp (containing 3 p. ct. of Carbon Monoxide) Present.	Effects on Man.	Effects on Lights.
2.0	After ½ hour or more, slight giddiness on exertion.....	Nil.
3.5	Inability to walk...	Nil.
7.0	Loss of consciousness.....	Nil.
10.0	Death	Burns rather dimly.
16.0	Death	Extinguished.

Firedamp.—What quantity or percentage is inflammable and will render the use of naked lights dangerous?

Prof. F. Clowes states that, when air contains less than 5 per cent. of firedamp, it cannot be fired by a flame unless it is also mixed with a large amount of fine suspended coal dust. Messrs. Mallard and Le Chatelier give 5.6 and 6 per cent., whilst the English Commissioners' Report states that "our experiments with lamps in gas mixtures have led us to the conclusion that when little more than 4 per cent. of marsh gas is present, flame may be transmitted under circumstances which occur in a mine."

The Prussian Firedamp Commissioners made some experiments in 1887 with a naked light let down into a chamber filled with gas in varying proportions, and it was not until the mixture contained 6 per cent. of gas that the "phenomenon produced the impression of an explosion," and then comparatively feeble. They state "it would appear, therefore, that mixtures containing from 4 per cent. to 6 per cent. of marsh gas are by no means so dangerous as is generally supposed."

The French Firedamp Commission say that "with 6⅔ per cent., a feeble explosion occurred repeatedly."

It is important to remember that "firedamp" so called, is not always composed of precisely the same constituent parts; this variation of composition will account for the fact that sometimes it is more readily ignited in a safety lamp than at other times.

The presence of very fine coal dust in the air appears to completely alter the state of things. But here again opinions differ.

According to the English Commission explosions were produced by dust suspended in air traveling at a velocity of 600 feet per minute, when firedamp was present in proportions ranging from 2 to 2.75 per cent.; in currents of low velocity the same result was produced with a sensitive dust in the presence of 1.5 per cent.

According to the French Commission, with mixtures of air, coal dust, and firedamp, nothing occurred when the mixture only contained 4 per cent. of firedamp; when this proportion was exceeded, an unsteady flame existed for some seconds, very feeble, bluish or yellowish With 6⅔ per cent. a feeble explosion occurred repeatedly.

According to the Prussian Commission, in ordinary atmospheric air all varieties of coal dust are found harmless in the presence of naked lights. Even when this air contains as much as 4 per cent. of methane, this harmless character is maintained. If the air contains 4.5 per cent. or more, certain varieties of coal dust will induce an explosion in the presence of naked lights. At a proportion of only 5 per cent. of methane this explosion is incomparably more violent than is the case without coal dust of 6 per cent. methane.

According to Mr. W. Galloway, under suitable conditions a mixture of air with fine coal dust and containing only 1 per cent. of firedamp can be fired and give rise to an explosion.

Dr. J. S. Haldane says:

"It is well known that coal dust has a marked power of absorbing gases, so that any gas or vapor found in small proportions may easily be taken up by the suspended dust.

"It seems not unlikely * * * that such measures as the removal of excess of dust and the moderate or partial watering so elaborately carried out in many mines may increase, rather than diminish, the chances of a dust explosion."

Ordinary safety lamps will not indicate the presence of firedamp unless it amounts to 2½ or 3 per cent. of the mixture, but this depends to a very great extent upon the lamp and the illuminant used. With an oil flame, gas can only be detected when the proportion is about 3 per cent.; but with the benzoline flame, the caps will indicate percentages as low as 1.5 per cent.

The English Commission, already referred to, recommend the bonneted class of safety lamp. They recommend that all safety lamps should be provided with a shut-off appliance for the extinction of the flame produced by both the illuminants and by ignited gas within the lamp; also that in the case of bonneted lamps there should be two vertical slits at opposite sides to enable the miner to see that the gauze is in the lamp.

The lamp fixings should also be so arranged that it is impossible to put a lamp together unless every part is in its proper place.

Having got a lamp of the approved type, such lamp should be tested with varying mixtures of gas and air, in order to see what height of cap, on a given sized flame, would be produced with the illuminant in use at the colliery. In this case a deputy could report the amount of gas, according to a scale, which could be fitted to the lamp, in the same way he reports the water gauge.

Every lamp should be tested regularly in an explosive gas mixture before it is given out to the workmen.

The gases produced by the detonation of 7 ounces of gunpowder measure 1.92 cubic feet, and have the following composition :

	Per Cent.	Cubic Feet.
Carbon dioxide.....	49.9	0.95808
Carbon monoxide...	14.1	0.27072
Nitrogen	33.3	0.63936
Sulphureted hydrogen.....	2.7	0.05184

To become harmless, the carbon dioxide must be reduced to 1 per cent., the carbon monoxide to 0.02 per cent., the nitrogen increased to 77.95 per cent., and the sulphureted hydrogen reduced to 0.02 per cent.

Consequently (2,572 cubic feet of air ÷ 1.92 or) 1,339 times the volume of the gases given off by the explosion of the gunpowder will be required. According to the composition given by Mr. Orsman at a recent lecture, his figures being somewhat different from the above, 1,347 times the volume of the gases given off by the explosion of the gunpowder will be required. In a place, where a shot was fired with 188 cubic feet of air passing per minute, it took 12 minutes to make it clear, and 2,256 cubic feet of air were required, as against 2,572 given above.

In the report on "An Investigation as to whether the Fumes," etc. (from which the composition of the gases given off by powder is taken), it is stated, if 7 ounces of powder were fired in 540 cubic feet of air the proportion of carbon monoxide would not be dangerous, but they give 0.05 of carbon monoxide, and according to Dr. J. S. Haldane this amount is not safe. It is further stated, "if an interval of 5 minutes be allowed to elapse after the firing of the shot before the hewer commences to work, no ill effects will be experienced from the fumes." This statement shows that (540 cubic feet × 5 or) 2,700 cubic feet are required to purify a working place after a shot is fired.

Of course, it will be at once seen that if a place has a large quantity of air passing, work may be more speedily resumed after firing the shot, but in any case, after the shot is fired, about 2,500 cubic feet of fresh air are required to make the air in the place as pure as the air was before the shot was fired, and this air sometimes contains 0.11 per cent. of carbon dioxide. It, therefore appears that at least 500 cubic feet of air per minute are required for every shot fired to dilute the gases given off by the explosive, depending upon the purity of the air in the first instance.

The Austrian Commission refer to the danger of gas coming out of the goaf by reason of barometrical depression, which should be guarded against. All unused roads communicating with the goaf should be closed on the intake and dip side by good stoppings or several feet of stowing, but on the return and rise side they should be left open and a return airway kept to carry off the gas. In long wall working, complete stowage of the goaf is enjoined.

In a case known to the writer, it was found necessary to drive a gas level to drain off the gas, in the same manner as a water level drains off water. The particular district was exceedingly gaseous, numerous outbursts of gas had occurred, and various methods were adopted to cope with it ; in driving straight work the gas came off in blowers, which could be felt by the hand at a distance of some 30 inches from the face. The working faces had to be stopped at intervals for days in order to allow the gas to drain off. When the coal was being worked the outbursts still went on, and bore holes were put down in the gate roads, which showed signs of having heaved up (owing to a pressure exerted from beneath). The ventilation had, therefore, to be specially arranged to prevent the gas from coming into contact with the workmen.

It appears, from a perusal of a foreign commissioner's reports, that far more care is taken on the Continent to prevent loss of air through stoppings, overcasts, etc., than is the case in this country. The writer ventures to say that of the total ventilating current in many collieries, particularly the older ones, as much as 10 per cent. is lost in the main roads, engine planes, etc., through defective stoppings (about 500 cubic feet per minute per 1,000 feet of airway); 15 per cent. is lost on the levels and branch roads, through stoppings, doors and overcasts ; and 15 per cent. is lost between the levels and the working face, or 40 per cent. in all. Consequently, in a mine with a total intake air current of 150,000 cubic feet per minute, only 60 per cent. of this quantity, or 90,000 cubic feet, will actually pass the working face. Members will find it interesting to test these figures by actual measurements in collieries under their charge.

The writer advises that more care should be taken in making the stoppings air-tight—in the first instance, the slits or bolt holes should be driven as small in every way as possible, and the pillars between the intake and return airways made as thick as possible, a good wall should be built and well plastered, and the slit stowed tight up. In the proposed Coal Mines Act of 1897 it is suggested that overcasts should be made in solid rock. More care should also be taken in erecting doors ; walls should be built at each side, at right angles to the door frame, so as to prevent leakages of air through breaks in the coal.

In order to ascertain the amount of gas given off in a particular district, the ventilating current should be so reduced (when the pit is idle) as to just show a given cap on a safety lamp, with a given current; say the current was reduced to 5,000 cubic feet per minute, and the lamp indicated 5 per cent. of gas ; then there would be 250 cubic feet of gas per minute produced, and to reduce this down to 2 per cent., at which it would be invisible on an ordinary safety lamp, would require (50 times 250 cubic feet, or) 12,500 cubic feet of air per minute.

General Conclusions.—The volume of air required for workmen, etc., is as follows :

	Cubic Feet per Minute.
Each person requires ordinarily, when at work.....	20
Do. when in a working place giving off ½ per cent. of gas	40
Do. with ½ per cent. of gas, to reduce it down to ½ per cent.	55
Do. " 1 " " " "	80
Do. " 1½ " " " "	107
Do. " 1¾ " " " "	115
Do. " 1½ " " " "	160
Do. horse requires...	90
Do. safety lamp requires.....	0½

Improved Pneumatic Tools for Foundry Use.

[A paper read by MR. GEORGE H. ROBBINS at the last (Philadelphia) monthly meeting of the Foundrymen's Association.]

The use of pneumatic tools for cleaning and chipping castings is not new. Certain defects in the old style of construction, the want of knowledge of how to operate them, together with the prejudices of ignorant workmen, have resulted in eight cases out of ten in the condemnation of the tools for foundry use. The first thing we will deal with will be the objectionable features of the old style of tools, of which the recoil or kick was the most noticeable. This recoil or kick has done more to prevent the adoption of large sized pneumatic tools than anything else, as it has enabled the workman who is afraid of losing his place to say. with some appearance of truth, that holding the tool was injurious to him, producing a paralysis of his arm, etc. To this, and here, let me reply that I know of men who have been running pneumatic tools continuously for the past five years, and who have not been affected in the slightest by them in any way whatever. The improved Clement valveless tool is so constructed and so evenly balanced that all kick has been eliminated from it, because it has an air cushion so placed that when in operation the workman is really pushing against air, the elasticity of which takes up all shock and vibration.

Another important objection that is made to the old style pneumatic tool is that so many small parts, valves, springs, etc., enter into its construction. Such a number and variety of parts make the tool very delicate and liable to get out of order.

The improved Clement valveless tool consists of but three parts or pieces—a cylinder that is bored out of a solid piece of steel, a hammer or piston made of tool steel and a butt piece or plug to close the end of the cylinder. The only part of it that moves is the hammer, and that is not dependent on the movement of any other part for its own motion. If it is given fair treatment and regularly oiled it can be depended on for a long period of steady and reliable service, and knowing this we are warranted in guaranteeing it against all repairs for two years. This, I trust, shows plainly and conclusively to any investigator that the objectionable features in the pneumatic tool of the past are not to be found in the improved Clement tool of to-day.

Let me now speak a moment of the ignorance of operating, and the prejudice existing against pneumatic tools and the reason therefor. No doubt some of you have had pneumatic tools tested in your foundries and perhaps unsuccessfully. Have you, however, considered in such a case how this test was made? Pneumatic tools are made in many sizes, and to use them to advantage they must be used for the purpose to which they are adapted—that is, a small tool for light work and a large tool for heavy work. Then again, at what air pressure did you try this tool? Do you know whether the pressure used was high enough to develop the efficiency of the tool? And last, but not least, in whose hands was the tool placed for trial? Was he a man who would work for your interests, forgetting his own, or was he opposed to the tool because it was a labor-saving device, and because its adoption was liable to bring about the discharge from employment of

himself or some of his shopmates? These are all-important considerations, and may explain to you why the test of pneumatic tools in your shop was a failure, if such it was.

The best way to introduce the tools is to place them in the hands of young men, who are, as a rule, ambitious, and who will take a pride in running a new machine. Let them know that the successful operation of the tool will mean a slight advance in their wages. If on the contrary, however, you give the tools to a man who believes only in old hand methods, then the amount of work that he will turn out will be, comparatively speaking, small.

The average amount of work that can be done with these tools is as follows: In removing sand from large and heavy castings, one man with a medium size tool and a broad chisel can readily do as much work in a given time as six men could do by hand methods. One man with a tool can do as much light fine chipping as is usually done by five men in the same period of time; and in rough or heavy chipping one man with the proper size tool can do about the same quantity of work that is generally done by three or four men with the hammer and chisel.

It is sometimes necessary to do chipping to a line, or true surface. A man who is skilful enough to do this class of work with a hammer and chisel can accomplish just twice as much in the same time by using a pneumatic tube for the purpose. The operator has absolute control over the tools used for this fine work, striking a light or heavy blow as he desires, governing the force of the blows by the simple pressure of his hand, and not by throttle valves, etc., that are so liable to wear out.

If any one should doubt the possibility of the operator being able to cut to a line, or having this perfect control over the tool, it affords me pleasure to refer you to the marble and granite cutter, who not only does the most delicate carving and lettering with the tools, but does it on a substance that is vastly more friable and brittle than cast iron.

An air compressor, and an air receiver and a lot of different sizes of pipe strung around the shop do not always constitute either an efficient or economical air plant. To get the best results there is required:

1. An air compressor of approved pattern, of sufficient size and power to develop and maintain a steady pressure of 80 to 100 pounds to the square inch.

2. An air receiver of sufficient size to equalize the pulsations of the compressor and to cause the air to flow with uniform velocity to the tools.

3. As air in its passage through pipes is subject to friction in the same manner as water, it is important that your pipe system be carefully designed, as loss by friction may be quite serious. In calculating such loss it would be well to remember that the difference in pressure between the entrance to the pipe and the point of use, termed in hydraulics "loss of head and power lost," is not applicable to compressed air. Compressed air will lose 10 per cent. of its head, but the loss of power will only be about 3 per cent. The reason for this is simple when you remember that compressed air as it loses in pressure gains in bulk, and thus in a measure by its increased volume compensates for the diminished pressure.

Discussion.

Mr. Howard Evans—You do not mention the amount of power required to drive the compressor, nor state the saving over hand work where the tools are used. You only say that one man can with one tool do so much more work than by hand.

Mr. Robbins—An air compressor of a size sufficient to operate say three tools, 14-ounce hammers, would require 4 horse power to run it—that is, a belt compressor. When a small compressor can be used it is much more economical to run it by belt power than by steam direct. The cost of such a compressor would be in the neighborhood of $180. The cost of the air receiver would be about $40, while the cost of the pipe would depend altogether on the distance the air was to be carried; if 100 feet, say $5. Three tools of the capacity mentioned would cost say $3000. A total cost of about $525 for the equipment.

Mr. Evans—Where people have a compressor in already the adoption of these tools is accompanied with considerably less expense, is it not?

Mr. Robbins—Certainly. I have here a small 2-ounce tool the earning capacity of which is $900 per annum. That is the earning without the expense. The tools actually save the labor of one man for 300 working days in the year. The outfit I have mentioned is large enough to run six of these tools. In taking sand off castings you would require a broad chisel like this (showing a chisel with about 2-inch cutting edge).

Mr. Messick—Are the tools in use in this city?

Mr. Robbins—Yes. They are used at Cramp's, and at the works of the Warden Manufacturing Company, in both boiler shop and foundry. They are used in shipyards for chipping and calking. When used for calking a man can calk 60 lineal feet per hour; on boiler work about 40 feet. It makes a tighter joint than is possible by hand, the blows not being so hard, but multitudinous. The tool I have shown you uses 10 feet of air per minute at 80 pounds pressure. It can be operated with a pressure as low as 60 pounds, but high pressure is the best, the resulting work being much more efficient.

Mr. Messick—Did you ever try driving rivets with them?

Mr. Robbins—Yes; what you call shell rivets; ⅝-inch cold rivets. A 6-pound hammer will drive them faster than you can put them in the hole.

Mr. Eldridge—Supposing one wished to knock off a riser from a casting, say a riser 2 inches in diameter, would you smooth the casting with the tool as well?

Mr. Robbins—A sledge would be better for knocking off a gate of that size. After the gate is knocked off you can smooth down with the pneumatic tool.

Mr. Evans—Supposing a foundryman having a compressor wished to try these tools, would you give him a trial?

Mr. Robbins—Certainly. He could have them for ten days on trial, and we would visit his foundry and impart all instruction possible.

The Value of the Expert.

A feature of the dedication of the new Museum Building of the Brooklyn Institute of Arts and Sciences was an address by President Charles W. Eliot, of Harvard University, whose theme was the "Function of Education in Democratic Society." During the address President Eliot had this to say respecting the value of the expert:

Anyone who has attained to the capacity for exact observation and exact description, and knows what it is to draw a correct inference from well determined premises, will naturally acquire a respect for these powers when exhibited by others in fields unknown to him. Moreover, any one who has learned how hard it is to determine a fact, to state it accurately, and to draw from it the justly limited inference, will be sure that he himself cannot do these things except in a very limited field. He will know that his own personal activity must be limited to a few subjects if his capacity is to be really excellent in any. He will be sure that the too common belief that a Yankee can turn his hand to anything is a mischievous delusion. Having, as the result of his education, some vision of the great range of knowledge and capacity needed in the business of the world, he will respect the trained capacities which he sees developed in great diversity in other people; in short, he will come to respect and confide in the expert in every field of human activity. Confidence in experts, and willingness to employ them and abide by their decisions, are among the best signs of intelligence in an educated individual or an educated community; and in any democracy which is to thrive, this respect and confidence must be felt strongly by the majority of the population. In the conduct of private and corporation business in the United States, the employment of experts is well recognized as the only rational and successful method. No one would think of building a bridge or dam, or setting up a power station or a cotton mill, without relying absolutely upon the advice of intelligent experts. The democracy must learn, in governmental affairs, whether municipal, State or National, to employ experts and abide by their decisions. Such complicated subjects as taxation, finance and public works cannot be wisely managed by popular assemblies or their committees, or by executive officers who have no special acquaintance with these most difficult subjects. American experience during the last 20 years demonstrates that popular assemblies have become absolutely incapable of dealing wisely with any of these great subjects. A Legislature or a Congress can indicate by legislation the object it wishes to attain; but to devise the means of attaining that object in taxation, currency, finance, or public works, and to expend the money appropriated by the constituted authorities for the object, must be functions of experts. Legislators and executives are changed so frequently under the American system of local representation that few gain anything that deserves to be called experience in legislation or administration; while the few who serve long terms are apt to be so absorbed in the routine work of carrying on the government and managing the party interests that they have no time either for thorough research or for invention. Under present conditions neither expert knowledge nor intellectual leadership can reasonably be expected of

them. Democracies will not be safe until the population has learned that governmental affairs must be conducted on the same principles on which successful private and corporate business is conducted; and therefore it should be one of the principal objects of democratic education so to train the minds of the children that when they become adult they shall have within their own experience the grounds of respect for the attainments of experts in every branch of governmental, industrial and social activity, and of confidence in their advice.

Bovee's Device for Separating Gas and Water from Oil.

On the 11th inst. U. S. Letters Patent (No. 597,258) were granted to Mr. M. W. Bovee, of Goodwill Hill, Pa., for an improved device for separating gas and water from oil. Using the words of the specification:

The object of this invention is to improve upon the construction of a similar device, for which Letters Patent were granted to Benton Gilmore, February 11, 1896, No. 554,598, the construction in the improvement being such that the device is very much simplified and rendered much more effective in operation.

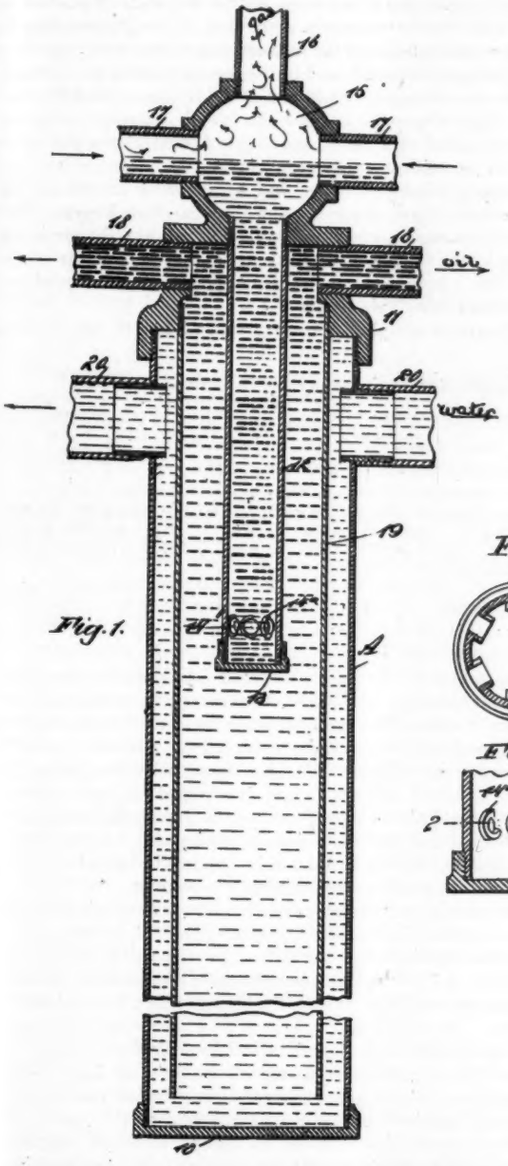

Fig. 1.

Fig. 2

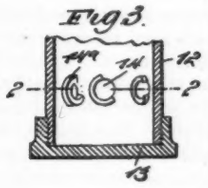

Fig. 3.

A further object of the invention is to provide an efficient means whereby the gas and water may be separated from the oil after the same has issued from the well and before it reaches a tank, thereby saving the expense of small tanks and also preventing a large share of evaporation of oil in warm weather and slush in cold weather, and likewise saving the expense and labor attendant upon the use of steam.

The invention consists in the novel construction and combination of the several parts, as will be hereinafter fully set forth, and pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a longitudinal vertical section through the device. Fig. 2 is a horizontal section through the interior separator, the section being taken at the bottom of the same, as indicated by the line 2 2 of Fig. 3; and Fig. 3 is a vertical section of the lower portion of the interior separator, drawn on an enlarged scale.

A casing *A*, preferably of cylindrical form, is provided, closed at the bottom by a cap 10, being provided at the top with a second cap 11. The upper cap 11 has an opening in its top portion, in which the upper end of a separating cylinder 12 is secured, the lower end 13 of said cylinder being closed. Near the lower end of the separating cylinder 12, apertures 14 are made therein, and each aperture is partially surrounded by a flange 14a, formed upon the inner wall of the cylinder. These flanges tend to give the fluid an upward revolving motion, effecting a very rapid and effective separation and making it possible to separate a large amount of liquid by the use of a small-sized separator.

The upper cap 11 has a casing formed around the opening in which the upper end of the separator 12 is secured. This casing is usually of circular form in cross section, and the chamber 15, provided by the casing, is adapted to receive the combined oil, gas and water as it comes from the well, being introduced into the chamber through pipes 17, and at the top of the chamber 15 a pipe 16 is located, adapted to conduct away the gas from the material supplied to the chamber.

Near the top of the cap 11, below the point where the inner separator 12 is connected therewith, pipes 18 are introduced, through which the oil when separated from the water and the gas flows off to a suitable receptacle, and below the cap 11 in the main casing or cylinder *A* pipes 20 are introduced, through which the water finds an escape.

The inner casing or cylinder 19 is secured at its upper end to the top cap 11, the inner casing or cylinder 19 being so placed as to surround the inner separator 12, and the inner casing or cylinder 19, which is also a separator, is open at its bottom and extends downward within a short distance of the bottom of the main or outer casing or cylinder *A*, as shown in Fig. 1.

The liquid received from the well enters the chamber 15, as heretofore stated, and the gas passes off through the top pipe 16. The oil and water find an escape through the opening 14 in the bottom of the inner separator and enter the outer separator 19, whereupon the oil, being lightest, flows to the top of the said outer separator and passes off through the pipes 18, whereas the water leaves the outer separator at the bottom and passes up between the outer separator and the outer casing *A*, finding escape through the exit pipes 20. The outer separator 19 serves to effect a speedy and thorough separation of the oil from the water, and the entire device is simple, durable and economic in construction.

The inventor's claims are:

1. A device for separating two liquids of different specific gravity, comprising a chamber having outflow openings at top and bottom, the lower discharge being against a head a little less than that of the upper, and a supply pipe projecting axially into said chamber and having discharge jets at its inner end giving the mixed fluid a rotary motion, substantially as described.

2. A device for separating two liquids of different specific gravity comprising a chamber having outflow openings at top and bottom, the lower discharge being against a head a little less than that of the upper, a supply pipe projecting axially into said chamber having discharge openings at its inner end, and flanges partially surrounding said openings whereby a rotary motion is given to the fluid surrounding the discharge pipe, substantially as described.

3. A device for separating two liquids of different specific gravity, comprising a vertically disposed separating chamber having outflow openings at top and bottom the discharge from the latter being under a head slightly less than the upper, a supply pipe centrally placed and entering the chamber at its upper end, the lower end of the supply pipe having discharge openings circumferentially disposed and flanges inside the pipe partially surrounding said openings whereby the fluid is given a whirling motion in the surrounding chamber, substantially as described.

4. A device for separating two fluids of different specific gravity com-

prising a vertically disposed separating chamber which is open at the bottom and has outflow connections at its top, a chamber surrounding the separating chamber from the upper end of which the separating chamber is suspended so as to permit a discharge beneath its lower end, said outer chamber having discharge outlets slightly below those in the top of the separating chamber, a supply pipe suspended from the top within the separating chamber having discharge openings circumferentially arranged about its lower end, a gas separating chamber connected to the upper end of this pipe having supply pipe connections and having also a gas conveying pipe connected to its upper part, substantially as described.

The Technical Analysis of Calcium Carbide and Acetylene and the Purifying of the Latter.

The *Gas World* reports that the following is the method proposed by Messrs. G. Lunge and E. Cedercrutz to determine, analytically, the possible 4 per cent. of impurities in acetylene, among them phosphureted hydrogen, ammonia, carbonic oxide, hydrogen, nitrogen and oxygen.

Sampling.—The examination of carbide is rendered quite difficult by the fact that the blocks of the commercial material are never quite homogeneous. It is, therefore, necessary to take an average sample, obtained by thoroughly mixing a considerable quantity of crushed carbide and sampling it. The usual method is, however, not applicable, as a considerable time must elapse while the carbide is being crushed, mixed and sampled; during this time the moisture of the air attacks the carbide and decomposes a weighable quantity. No method, however, remains but to quickly break the carbide into particles the size of a pea, to facilitate thorough mixing, and then to take equal samples of these particles, from 50 to 100 grams, for each examination.

Thus, one is not certain of obtaining a rigidly accurate average sample. This would, however, be possible where large pieces are taken from various parts of the fused mass and put into a closed ball pulverizer or similar mill, by which the air is kept away and the pulverized carbide is mixed while it is being ground. For an analysis, about 10 grams of this powder are taken and tested with a graduated glass gasholder holding about 3 liters of gas. The sample vessels should be so arranged as not to contain moisture at any time, so that about 50 to 100 grams of carbide should always be left in them.

Generation.—From 100 grams of chemically pure calcium carbide are produced 40,625 grams of pure acetylene, which, at 0° and 760 mm. pressure, and without moisture, will occupy a volume of 34.877 liters.

Commercial carbide naturally gives off less gas, but should not produce less than 300 liters per kilogram of carbide. Where one measures this gas at any temperature and pressure whatever, and with moisture in the gas, under which conditions its volume may increase by 20 per cent., the size of apparatus must be increased proportionally, so that for a 100-gram sample a gasholder of 40 liters capacity should be used. If, on this account, the usual laboratory apparatus will not serve, an apparatus can be built, consisting of a tin cylinder, open at the top, in which is placed an inverted tin counterweighted bell. To fill this gasholder, the usual inverted siphon tube can be used, or a rubber tube can be connected with the top of the bell in such a manner as not to interfere with its rising or falling. Another tube, with stopcock, is also connected with the top of the bell, through which gas can be drawn when wanted. By means of a gauge the volume of gas can be read off at once.

Acetylene is slightly soluble in water, and, therefore, the water seal of the gasholder should not, under any conditions, consist of distilled water, nor any other but that which is already saturated with acetylene. A concentrated solution of salt in water takes up very little acetylene, but must have been used once before with gas to be admissible. The apparatus for generating the gas from the weighed quantity of carbide is either placed in an alembic or glass flask and water allowed to drop upon it; or the flask may contain a saturated solution of salt in water, and the carbide weighed in a tube, which is then inserted into the end of a large dry rubber tube projecting from the flask, and the carbide allowed to fall into the solution. In order that the generation of gas should not be too violent, a strong pinchcock should be placed on the rubber tube, by the use of which as much carbide could be let down at a time as might be desired. In a few minutes all the gas is given off, which naturally comes off by shaking. The latter method has the advantage of the former, in that the retort need not be carefully dried before using.

Analysis.—The worst impurity is phosphureted hydrogen. In order to determine this gas in acetylene, Willgerodt (Ber. Deutsch Chem. Ges., 1895, p. 2,107) oxidized it to phosphoric acid by means of bromine vapor. As this requires large quantitities of bromine, it is scarcely applicable for technical analysis. It is better to burn the acetylene and then to lead the consumed gas through solutions which absorb the phosphoric acid; these methods possess the serious disadvantage of losses occurring by means of the phosphureted hydrogen dissolving in the gasholder water. This suggests the burning of the acetylene directly as it is generated by water dropping upon the carbide, although it is necessary here to keep the flame of the same size and to avoid the formation of soot, in order to obtain any satisfactory results.

Chloride of lime has the property of oxidizing phosphureted hydrogen at certain temperatures only, so that it cannot be used direct for analytical purposes. A solution of hyposulphite of soda, obtained by treating a calcium chloride solution with carbonate of soda, will serve the purpose very well; the filtrate absorbs phosphureted hydrogen with avidity, and the phosphorus can be determined, as usual, by the magnesia-mixture method. An excess of hypochlorites, in our opinion, is no disadvantage.

For the practical application of this method of analysis, a thoroughly dried out half-liter flask is uecessary, into which are placed 50 to 70 grams of carbide, in particles the size of peas. Carbide dust should not be put in, as the evolution of gas is too violent. In the neck of the flask is inserted a dropping tube drawn out at the end. The flask is connected with a 10 bulb absorption apparatus, although two may be used for a large production; in the authors' experience there was very little, if any, phosphoric acid found in the second apparatus. The absorption bulbs were charged with 75 cm. of a 2 to 3 per cent. hypochloric solution, which was found about right for all practical purposes. The dropper was filled with water, and the flow so regulated that six to seven drops fell per minute. The apparatus can be left to itself if one keeps the dropper filled with water and occasionally shakes up the flask. Generation of gas continues for three to four hours. Then enough water is allowed to run into the flash to fill it to the neck, the gas remaining in the tubes is sucked through, and the contents of the bulbs poured into a beaker, in which the phosphorus is precipitated and determined as magnesium phosphate.

Analyses of carbide samples from two works (A and B) are given as follows:

Phosphureted Hydrogen (PH_3) in Calcium Carbide.

	Works A.		Works B.			
	1	2	3	4	5	6
Weight taken, grams	49.997	55.990	68.997	63.639	56.445	57.900
$Mg_2P_2O_7$, grams	0.0232	0.0266	0.0794	0.0812	0.0628	0.0530
Ca_3P_2, per cent.	0.0380	0.0389	0.0942	0.1013	0.0912	0.0750
PH_3 per kg. carbide, grams	0.142	0.145	0.352	0.378	0.341	0.280
PH_3 per kg. carbide, cc.	93.1	95.1	241.0	24.8	224.0	184.0

The same apparatus can be used to determine the quantity of sulphur present. The best method is to use a magnesia mixture free from sulphuric acid, and to determine the sulphuric acid in the filtrate from the magnesium pyrophosphate solution, acidulating with hydrochloric acid, and precipitating with chloride of barium as barium sulphate. In this way the principal impurities are determined; it also must be noted that the quantity of sulphur found in the gas depends also upon the manipulation of the carbide, the temperature and the generating water. In any case, the sulphur is not in the gas in the form of sulphureted hydrogen alone, but also as other compounds.

As previously explained, the phosphoric acid was determined by the use of a hypochlorite solution of definite strength. A known part of the hypochlorite solution can be taken after the acetylene gas has passed through it, and the sulphur determined with a known quantity of sodium arsenite added in excess, the excess being determined by titrating back.

Most of the hydrogen sulphide can also be removed previously, by placing before the hyposulphite absorption bulbs a similar 10-bulb apparatus containing 75 cm. of a 10 per cent. solution of lead acetate. We determine the sulphur which escapes the lead acetate, and is absorbed by the hyposulphite solution, by adding sufficient magnesia mixture, after having acidulated with hypochloric acid, and precipitate the sulphur with barium chloride as barium sulphate, which is filtered, dried and weighed in the usual manner. The method for the determination of sulphur as above described is satisfactory, *i.e.*, running the gas direct through a hypochlorite solution, which, of course,

must be free from sulphates; after this, the phosphoric acid can either be precipitated by the magnesia mixture, the filtrate being acidulated and the sulphur thrown down by barium chloride, or one can divide the hypochlorite solution into two parts, determining in one the phosphorus and in the other the sulphur.

The above method is applicable to the analysis of commercial acetylene, and permits of modifications where such are necessary. In this connection we may mention ammonia, which is liable to be found in acetylene in traces, and which is injurious, because it favors the formation of acetylide of copper, an explosive compound which may cause the acetylene itself to explode.

Purification.—In the commercial purification of acetylene, hyposulphite of sodium cannot be used, of course, but chloride of lime can, by reason of its cheapness. This chloride of lime can be used as a solution or thin liquor, through which the acetylene is permitted to pass or to come in contact with. It is more convenient, however, to use chloride of lime in the solid form in the presence of sufficient moisture to secure good working. According to the tests made by the authors the best way is to form the chloride into lumps with a small quantity of water, so that the gas can pass through readily; pulverised chloride offers too much resistance and also causes dust to rise. It would be better to put behind the vessel holding the chloride of lime another containing lime, which would catch anything brought over from the chloride vessel.

On the other hand, the chloride of lime must not contain so much moisture as to become pasty and thus prevent the gas from penetrating. When the acetylene is too moist it can be cooled and the condensed moisture removed. Of course, a chemical dryer, such as concentrated sulphuric acid of gravity 1.6 to 1.7 is better. This dryer, or one less concentrated, can be also used to remove the ammonia, or other acids can be used in its place for the same purpose.

By using more vessels, they can be replaced when exhausted, others put in their place, and the phosphate and sulphate of lime removed.

Some Notes upon Typical American Gas Works.—No. 1.

By Traveler.

Wilmington, Del.—The nearest way to the gas works at Wilmington, as usual, is "right down the railroad track a bit;" and it is worth the walk to see a typical American gas works of its caliber, that daily says little, but "saws wood." The writer has heard Wilmington charged with being a bit conservative, to express it one way. Because it makes but little commotion in the gas world, however, or is but little heard from, doesn't mean that it isn't keeping its end up. Judge for yourself upon the facts. The city has 70,000 population, or thereabouts. The works are 16-inch throughout, and a model of orderliness. Superintendent Thomas Curley, an engineer of the old school, believes in and practices old-fashioned ideas of cleanliness and discipline. The pipes are painted, the walls whitewashed, and the floors and yard swept up throughout in a way gratifying to observe. The coal gas producing end of the plant is the older part. Having been steadily replaced by water gas, it is neither especially kept up nor attractive in appearance, being housed in old, low-roofed buildings. Fourteen benches of 5's and six benches of 6's comprise the bench equipment, all of customary type, excepting some Curley ideas embodied in the furnaces.

Adjoining are two sets of water gas apparatus, upon which 65 per cent. or more of the make is made. The first is an early Flannery set—so old that it looks strange indeed in its box-like shell. While it is of ill design and works unequally at many points, it yet served to show the advantages of a water gas annex, to such extent that in due time a second, larger set was built alongside. The only mistake about this was that Superintendent Curley thought he could cut out and put together a better coat than a tailor could make for him. That is, between himself and a Consohocken iron man a homemade water gas generator was put in, with the result that its capacity is only about a half or two-thirds that of the same size shells, had he secured a professional, experienced, outside water gas tailor to furnish it for him. The "cushion holder" system of connections is used, and the two gases, drawn by usual exhausters, pass through a set of Floyd boxes, 20 feet by 24 feet, and a McIlhenny 11-foot meter, into their so-called "Jumbo" holder of 500,000 cubic feet capacity, nearly. The coal gas further passes through a vertical 16-inch pipe battery air-condenser, a pair of wrought iron shells, with grids, for scrubbing, as well as a Standard rotary scrubber, all contained in new, light and commodious buildings, put up for this part of the manufacture along in 1883.

Throughout the works evidences of Supt. Curley's inventive ability, and of helpful contrivances are apparent. Electric bells from all departments, incandescent electric lights for safe examinations in questionable corners, Welsbach lights, with ever-ready bye passes at other points, fixed platforms above for cleaning scrubbers, extra good tar drains, special devices here and there, etc. In the yard one stands over—quite without noticing—the tar tank, as usual made from an old holder tank. While this was normal when the writer stood there, it was not so, at least one morning, when its wooden roofing gave way and 1,500 bushels or so of coke slid into it. Three stout steel girders now support the stone paving over it, making a tar tank, unsurpassed for roof at least; so a repetition of the accident is not likely. In one corner of the yard is the kiln, wherein the gas company makes its own lime, from that plentiful bye-product of Delaware Bay, old oyster shells. While this may be cheap, the use of at least 8 or 10 men (observed by the writer) in the purifier house, while cleaning a box, would seem to more than offset it. The writer thinks that the lime kiln has been worked long enough and that it would surely pay to give oxide a chance.

Off in the landscape, about a half mile away, is the plant of the Oxy-Hydrogen Gas Company, one of the few instances, if not the only instance of a gas works not being used after being built, not by agreement, but from necessity. It will be remembered that the Addicks' interests rejuvenated this Company eight or nine years ago, on the assumption that they could open the streets of Wilmington without the consent of the local authorities—in which assumption they erred. Leastwise the old Wilmington Company inspired the local authorities in question to say that they couldn't, which remark was clinched with an injunction; and from that day to this it has been in the courts, the Oxy-Hydrogen Company's pipe stopped at the railroad, and the splendid buildings and holder are shut down tight as a drum. Chancellors have died and have been legislated out of office—have come and gone—and for eight years law tactics and delay have served to keep the question in litigation and the new Company out. Meanwhile its charter expired. Such a thing as that, however, did not deter the resourceful Mr. Addicks. He merely had passed by the Delaware Legislature an omnibus bill renewing the charters of *all* expired corporations *for the term of their original existence*, only to then discover that in his own Oxy-Hydrogen charter *no term had ever been stated!* Yet it was easy to claim that in such case the customary term of 20 years becomes operative; and so the 9 years' fight is still on, unended and unlitigated to a finish. The Wilmington public, nevertheless, is not suffering particularly by the absence of a second company. The present one maintains a good office and gas stove department and display, and makes and sells a 22-candle power gas for $1.10 per 1,000 gross; $1 net. Is it not entitled to its good volume of business and its ditto, ditto, dividends?

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Advices from Montreal, Canada, are to the effect that negotiations are underway tending to the purchasing of a controlling interest in the Montreal Gas Company by English capitalists. If such an interest is for sale it is rather queer that some one of the gas syndicates of the United States did not discover the opportunity in time to forestall the acquirement of such a valuable property by foreign capitalists; for, certainly, the Montreal gas property, on the basis of its present capitalization, is an extremely valuable possession.

At the annual meeting of the New Albany (Ind.) Gas Light and Coke Company, the following officers were elected: Directors, J. K. Woodward, W. H. Welman, S. A. Culbertson, James W. Dunbar and George H. Devol; President, J. K. Woodward; Vice-President, J. W. Dunbar; Secretary and Treasurer, J. O. English.

The new plant of the Brockton (Mass.) Gas Light Company, located on the plot known as the Flagg tract, was put in work early this month. No hitch was experienced in its starting, and the new holder (its capacity is 208,000 cubic feet) worked admirably.

Through the negotiations conducted by Mr. W. A. Coombs, President of the Coldwater (Mich.) Gas Company, it has been decided to extend the mains of the Coldwater Company to the outlying village of Quincy. Quincy is situated on the main line of the Lake Shore and Michigan Southern Railroad, at a point about 6 miles east of Coldwater, and is noted for its factories for the working of wood into staves, heading, sash, doors, etc. Its population is about 1,800.

A MOVEMENT looking to the abolition of the office of State Gas Inspector for Indiana is underway. The argument made by those who favor the scheme is that the present Inspector (Mr. Leach) "has done incalculable injury to the general interests of the State through the turning away of investments caused by the statements that the supply and output of natural gas are rapidly failing."

THE Kenton (O.) Gas and Electric Company has retired its old mortgage issue of $50,000, by replacing it with a new issue of $60,000.

THE last dividend (a semi-annual of 5 per cent.) of the East Boston (Mass.) Gas Company has been payable since the 15th inst.

AT the annual meeting of the Newport (R. I.) Gas Company the following officers were elected: Directors, Henry Bull, Andrew K. Quinn, Philip Rider, Melville Bull, James C. Swan and Thomas A. Lawton; President, Henry Bull; Treasurer, A. K. Quinn.

MR. M. F. BURNS, for several years a Director in the Charlestown (Mass.) Gas and Electric Company, died at the home of his brother-in-law (Mr. Alpheus Bowers), 16 Brook street, Winchester, Mass., on the afternoon of the 16th inst. Deceased was born in Milford, N. H., May 24, 1841, obtained his education in the Appleton Academy, Mount Vernon, N. H., and subsequently taught school at various points in New Hampshire and New Jersey. In 1866 he settled in Charlestown, Mass., engaging in the milk business. In 1873 he removed to Somerville, where he became prominently identified with the local government. In 1880 and 1881 he was a member of the City Council (he was President of that body in 1881), and served as a member of the Board of Aldermen in 1882 and 1883. In 1884 he was chosen Trustee of the Public Library, and then served the city as Mayor for four successive terms—1885-86-87-88. He was prominent in Masonic circles, and, besides his Directorship in the Charlestown Gas and Electric Company, served the Monument National Bank and the Five Cents Savings Bank (both of Charlestown) in a similar capacity.

SUPERINTENDENT SNAPP, of the Winchester (Va.) Gas and Electric Light Company, has greatly improved the purifying system of the plant, with the result that the gas users are very much better satisfied with the illuminating agent supplied them. Now, if the Superintendent could only convince the shareholders that an additional holder would be a good thing for the Company, Mr. Snapp would be in a fair way to retain an easier mind.

THE beginning of the end of the reorganization at Detroit, Mich., is plainly foreshadowed in the filing of articles of association with the Secretary of State of the Detroit City Gas Company, which is capitalized in $5,000,000. The incorporators are: H. D. Walbridge, of Grand Rapids, Mich.; Herbert E. Boynton, Crapo C. Smith and Earl D. Babst, of Detroit; and W. F. Douthirt, of Glen Ridge, N. J.

THE Massachusetts Board of Gas and Electric Light Commissioners has authorized an issue of new stock, by the Boston Electric Light Company, to the amount of $800,000, for the construction and equipping of a new central station. The order provides that the sum shall be applied to the payment of liabilities incurred since December, 1897, or which may be incurred hereafter for the purchase of additional real estate, the building of a new generator station thereon, the equipment of the same, connecting them with other stations of the Company, the purchase of additional machinery and apparatus for use in said station, or in connection therewith, and for no other purposes. The market value of the stock, as fixed for the taking thereof by the shareholders, is put at $100 per share, and if there is any stock left after the stockholders have taken what they are entitled to, it shall be offered to the public at some place in the city of Boston, on a date which has been advertised in three Boston newspapers.

THE Darby Gas Company, of Darby, Pa., has been reorganized, with Mr. William T. Tiers, of Philadelphia, as the principal man in interest. The reorganization meeting was held in the Bourse Building, in Philadelphia, and the officers chosen were: Directors, William T. Tiers, Alfred C. Elliot, Wm. L. Verlenden, Chas. F. Cattell and Enos Verlenden; President, William T. Tiers; Secretary and Treasurer, Alfred C. Elliot; Superintendent, Charles F. Cattell.

MR. J. J. H. BASSETT, for many years Superintendent of the Pottstown (Pa.) Gas Company, died at his home in Pottstown, on the night of the 15th inst. Mr. Bassett who was born in England 65 years ago, came to America in his early youth, and had been connected with the gas industry of the United States, in one capacity or another, since 1870.

THE Riter-Conley Company, of Allegheny, Pa., has been awarded an important contract—in fact, the contract amounts to the virtual construction of the works—by the proprietors of the Peoples Gas Light and Coke Company, of Buffalo, N.Y. Under the agreement the Riter-Conley Company will erect a complete works, the connections of which are to be of the dimension of 24 inches, the plant to consist of a storage holder, in steel tank, rated to hold 1,750,000 cubic feet; a relief holder, of 150,000 cubic feet capacity; a steel frame purifying house, fitted with four boxes 30 feet by 30 feet; a steel frame boiler house, covering three 100 horse power boilers—the stack to the boiler house is to be of steel, and 140 feet in height; a generator house, adapted to contain two 8 feet 6 inches water gas settings, up to manufacturing 1,600,000 cubic feet per diem; and, the necessary oil storage tanks, yard connections, tar tanks, etc. The agreement further contains provisions for the construction of buildings and apparatus for the manufacture of coal gas, but we are unable to give any particulars or details relating to the dimensions or plan of construction of the latter.

THE syndicate headed by Mr. George M. Myers has assumed control of the lighting interests of Carthage, Mo., the name of the undertaking corporation being that of the "Carthage Light Company"—this syndicate also controls the Nevada (Mo.) Light Company—with Mr. J. H. Enright as Superintendent at both points. The Carthage plant will have to be rebuilt or overhauled, both as to its manufacturing and distributing divisions.

IT is with regret that we report the death of Mr. Burr Kellogg Field, Vice-President of the Berlin Iron Bridge Company, of East Berlin, Conn., who died at his home, in Berlin, Conn., on the morning of Thursday, Jan. 13, after an illness that lasted less than a week; in fact, the time between his taking sick and his death was so short that few of his friends were aware that he was ill. Deceased entered the Sheffield School, Yale University, in 1874, and graduated therefrom with the title of Civil Engineer, in 1877. Immediately after graduation he commenced practical work in the line of his tuition, on railroad construction in the West, his principal experience in this connection having been gained during the laying out and building of the Northern Pacific system. His particular effort in that system was his direction of the locating and constructing of the branch connecting the Yellowstone National Park with the Northern Pacific main line. In 1882 he was appointed Superintendent of Bridges for the corporation of Philadelphia, which post he resigned to accept the position of Assistant Engineer to the Berlin Iron Bridge Company. His advancement in the affairs of the Bridge Company was rapid, for at the time of his death he occupied the place of Vice-President, with general charge of all sales made by the Company. Since his connection with it the Company's business increased materially from year to year; in fact, the part played by Mr. Field was an important one in the development of the Company's trade, and his untimely death will be regretted by his associates, who understood him as a director and who appreciated him as a friend. His wife and two children survive him.

AT the annual meeting of the Adams "Nomatch" Light Company, the following Directors were chosen: Thomas Adams, Jr., Charles A. Seddon, Wm. V. Hall, R. C. Fessenden, Jno. S. Levis, F. V. Strauss and L. R. Strauss; President, Thomas Adams, Jr.; Vice-President, Charles A. Seddon; 2d Vice-President, William V. Hall; Secretary and Treasurer, George W. Gilbert.

MR. E. C. HATHAWAY, the wideawake Superintendent of the Capital Gas and Electric Light Company, of Frankfort, Ky., writing under date of the 16th inst., says: "It may be worthy to note that we have built a new building, 48 feet by 56 feet, and have rebuilt all our old machines, the machines having been made by ourselves. The materials were furnished by the Kerr Murray Manufacturing Company. The equipment consists of one 4-foot double superheater Lowe apparatus, and one 6-foot single superheater Lowe, both of which work nicely; and, if results are an indication, are quite as efficient as any that have been installed in this section of the country. This equipment puts us on 'Easy Street,' so far as output is concerned."

AT the annual meeting of the Dover (N. H.) Gas Light Company the officers elected were: Directors, Thos. B. Garland, Eli V. Brewster, John Holland, Chas. H. Sawyer and E. R. Brown; President, E. V. Brewster; Secretary and Treasurer, Thos. B. Garland.

THE Columbus (Ga.) Gas Company has installed an experimental line of Welsbach lamps for outdoor lighting on 12th street, that city.

(*Continued on page* 135.)

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(*Continued from page* 134.)

The lamps have attracted much attention, accompanied by equally favorable comment.

THE local authorities of Terre Haute, Ind., are considering the advisability of appointing an official gas inspector for that place.

THE voters of Duluth, Minn., at another special election, have assented to the purchase (for operation on public account, at the upset price of $1,250,000) of the plants of the Duluth Gas and Water Company.

THE incorporation of the Hampton and Old Point (Va.) Gas and Electric Company is being considered.

OUR suggestion that the Hackensack (N. J.) Gas and Electric Company was furthering the latter rather than the former division of its business seems to have been unfounded. The real facts over the matter are that the Company has largely extended its main system within the last twelvemonth, the adjoining borough of Maywood having been piped, with most satisfactory results in the instance of securing consumers. During the last half of 1897 the Company expended $11,000 in bettering its gas department. We are glad that our suggestion could be so easily shown to have none other than a theoretical foundation.

JOHN F. COX, George Gladden, Hugh Elliot, A. O. Ackard and Walter M. Lindsay have applied to the Governor of Pennsylvania for a charter for the Homestead Gas Company, which corporation proposes to supply gas for lighting, heating and power purposes in the place named.

AT the annual meeting of the Jeffersonville (Ind.) Electric Light, Gas, Heating and Coke Company the officers elected were: Directors, E. C. Eaken, A. A. Swartz, N. H. Myers, T. J. Lindley and J. E. Taggart; President, E. C. Eaken; Secretary and Treasurer, A. A. Swartz; Assistant Secretary, H. M. Glassbrenner.

THE Directors of the Hartford City (Conn.) Gas Light Company have perfected the following executive organization: President, Hon. James L. Howard; Treasurer and General Manager, Gen. Jno. P. Harbison; Secretary, Mr. Thomas Evans. These were all re-elections, and the vote in each case was unanimous.

AT a recent meeting (Jan. 14) of the Directors of the Gloucester (Mass) Gas Light Company, it was voted to put the gross selling rate at $1.50 per 1,000 cubic feet, payment within 15 days to entitle the user to a rebate of 20 per cent. The new schedule goes into effect, July 1, 1898, and under its operation Superintendent Coffin will have the satisfaction of knowing that the gas rate of his city is not far from being the most liberal one in the State, population, location and conditions of supply having been given appropriate consideration.

AT the annual meeting of the Williamsport (Pa.) Gas Company, the officers chosen were: Directors, John G. Reading, R. C. Reading, H. H. Pigott, John F. Laedlin, John M. Dean, Alex. Beede and C. K. Geddes; President and Superintendent, R. C. Reading; Secretary and Treasurer, Geo. E. Rentz; Assistant Superintendent, M. J. Winters; Solicitor, John G. Reading.

THE Philadelphia *Bulletin* says that a trouble saving device has been adopted by the United Gas Improvement Company in the issuance of bills. This is a coupon attached, which is sent with the check for payment, the consumer retaining the bill. General Manager Bodine has issued the following explanation of the new system:

"The changes in the form of gas bills and in the methods of their payment were made with the hope of saving trouble to our customers. It was hoped that by the coupon form we would accomplish the following objects:

First—In the case of anyone going to the gas office to pay a bill prompter sevice than in the past, through the cutting off of the coupon, and receipting of the bill by mechanical means, instead of a long wait in line occasioned by the necessity of registering each payment when received, as in the past.

"Second—To those who preferred to pay their bills by check, saving the old trouble of sending a stamped addressed envelope for the return of the receipt, by making the original bill and check, when properly endorsed and paid, act as a receipt.

"We found that many people desired to have a receipted bill to file away in addition to the indorsement on the check. We, therefore, supplemented this system by a letter acknowledging receipt of checks. This form of letter was not adopted until the end of the second day, and it is probable that some customers who had paid by check were not notified of its receipt, through the misplacing of envelopes or some similar cause. In any such case, if the customer will advise us, we will send an acknowledgment of the check.

"We propose, when the next bill goes out, to omit the provision for tearing off the coupon and to have the bill in the form in which it is rendered sent to the office with the check, when the body of the bill will be receipted and returned by the Company."

The Weak Point of Interior Wiring.

The *Electrical World* says that during the last few years interior wiring has passed through a most remarkable development, advancing from the cheaply insulated wire fished into place and fastened on wooden cleats to the high grade of wire in a highly insulating covering, protected in a heavy iron pipe, with solid cast iron or steel junction boxes and panel switchboards of the most substantial construction. In all these particulars practical perfection has been reached, as far as insulation, protection and reduction of risk are concerned, although there is still plenty of room for improvement in point of first cost.

The socket, however, remains practically what it was a decade ago. In one sense it is the most exposed part of the system. It is constantly being handled, and is subject to jerks and blows and strains of all sorts. Crowded in it are the exposed terminals of opposite polarity, and a number of small metallic parts. These are stamped or punched out of sheet or thin strip metal, and assembled in a form quite unsuited for the severe duty which they often must endure. It is probably a fact that nine-tenths of the short circuits and other troubles with interior wiring may be traced to the sockets. Alternate heating and cooling, the jerking of the key, and the twisting in of lamps require at this point a solid structure, instead of a frail assemblage of weak brass and porcelain pieces.

The Market for Gas Securities.

The clearing up of the driftwood about the preliminary consolidation of the gas interests of the Borough of Manhattan has had the effect of improving the values of all city gas shares. Consolidated sold to-day (Friday) at 187, and 185 was bid for it at the close. Standard common went to 140½ bid, and the preferred advanced to 153½. Mutual is 302 bid, and East River common is 79 bid. All this activity with strength is in spite of the fact that the Legislature has before it at least five bills seeking to put the gas rate at $1 per 1,000, along with other restrictions concerning the manufacture and distribution. Senator Coffey was rather late this session introducing his "ancient measure," but it came to hand yesterday. There is little doubt that the beginning of the end in the instance of consolidation is in sight.

Brooklyn Union is strong, as is Consolidated of Baltimore, which is reported at 57½ bid. Peoples, of Chicago, is a trifle lower than last week, while Bay State moved beyond 5 for a time to-day. The Laclede Company has declared a dividend of 3 per cent. on the preferred, which payment finishes up all arrearages on accumulative account, and puts the preferred on a 5 per cent. basis. The Company has also declared a dividend of 1½ per cent. on the common. Cincinnati gas sold up to 208, with that figure bid for more of it. The general situation is all on the side of the investor.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 Wall St., New York City.

January 24.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$36,280,000	100	185½	184
Central	500,000	50		..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	215	222
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	302	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150,000	50	..	
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	79	..
Preferred	2,000,000	100	112	115
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	105	106½
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	140½	..
Preferred	5,000,000	100	153½	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	115
Yonkers	299,650	50	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	120½	121
" " Bonds (5's)	15 000,000	1,000	113½	114½
Bay State	50,000,000	50	5	5½
" Income Bonds	2,000,000	1,000	..	75
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	93¼	97
2d " " "	3,000,000	1,000	..	83
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Company	25,000,000	100	97¼	97⅜
Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus	1,089,000	.	91	94
1st Mortgage	1,085,000	..	..	96
Consumers, Jersey City	7,000,000	100	77	..
" Bonds	600,000	1,000	102	105
Cincinnati G. & C. Co	8,500,000	100	218	209
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	57⅛	57¼
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit	4,000,000		55	57
" Con. Bonds	4,312,000	..	97	97¼
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	81	93
" Bonds	2,000,000	..	93	95
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	118	125
" Bonds, 6's	2 650,000	..	107	109
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind	1,000,000	100	86	88
Bonds	1,000,000	1,000	92	94
Louisville	2,370,000	50	..	..
Laclede, St. Louis	7,500,000	100	46½	47½
Preferred	2,500,000	100	94	95
Bonds	9,084,400	1,000	103½	104
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co	1,000,000	..	220	220
Bonds, 6's	4,000,000	..	128	1 0x
New Haven	1,000,000	25	225	..
Oakland, Cal	2,000,000	..	53½	54
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	95¾	96
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000		87½	90
San Francisco, Cal	10,000,000	100	94	94½
St. Paul Gas Light Co	1,500,000	100	49	51
1st Mortgage 6's	650,000	..	84	87
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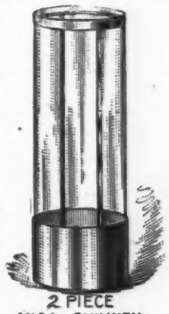

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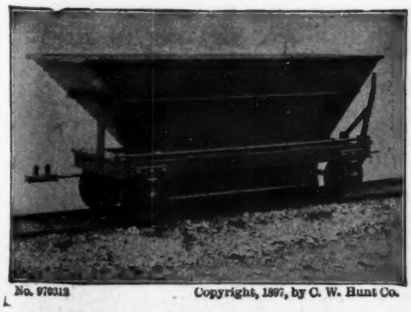

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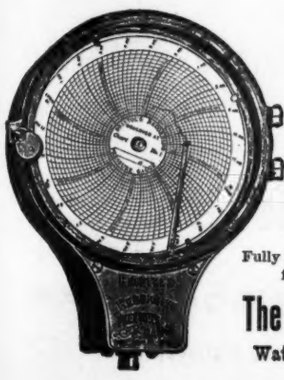

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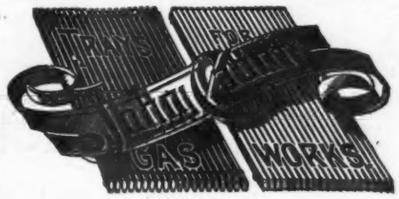

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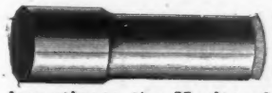

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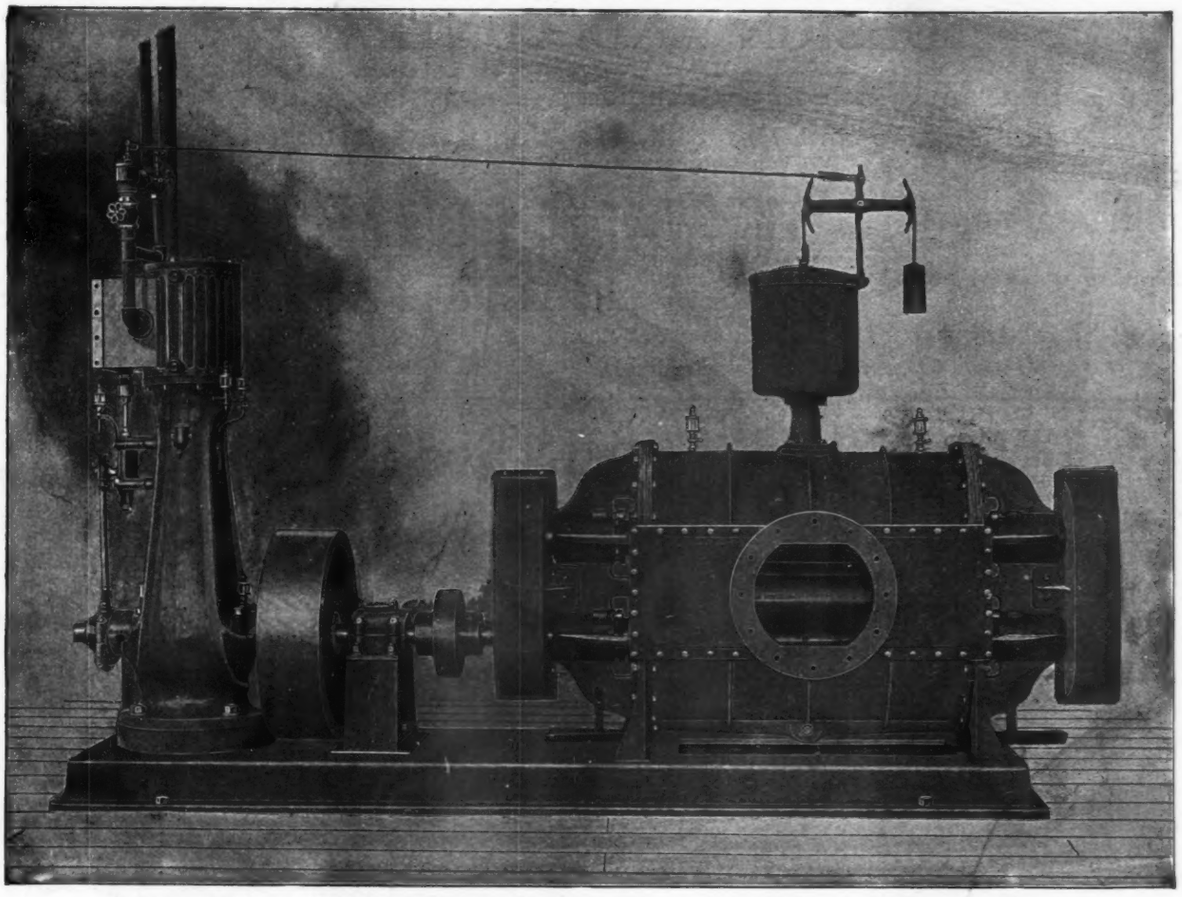

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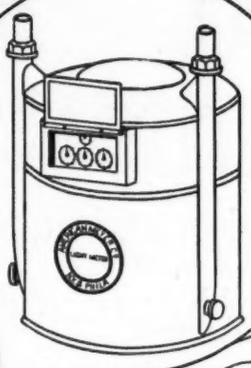

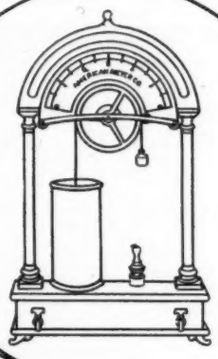

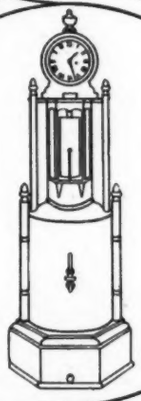

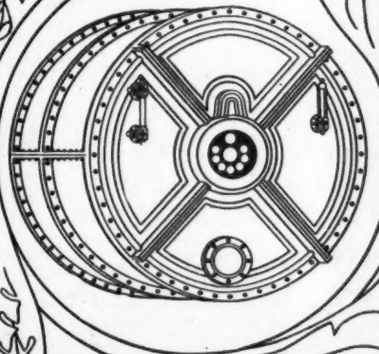

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NEW YORK AND PHILADELPHIA,

CHICAGO, ST. LOUIS,

SAN FRANCISCO.

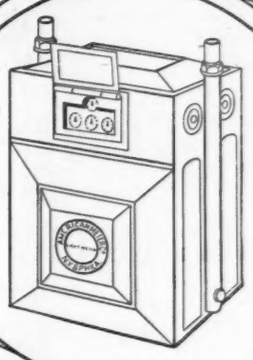
PUBLIC LIGHTING TABLE.

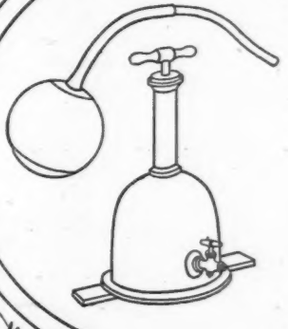
FEBRUARY, 1898.

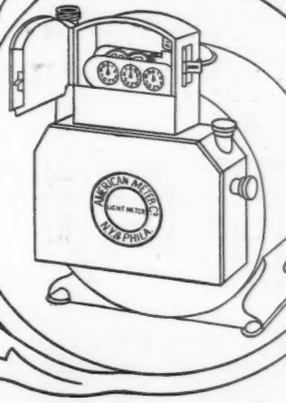
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Tue.	1	3.20 AM	6.10 AM	5.05	6.15
Wed.	2	4.10	6.10	5.05	6.15
Thu.	3	4.50	6.10	5.05	6.15
Fri.	4	5.20	6.10	5.05	6.15
Sat.	5	No L.	No L.	5.10	6 10
Sun.	6	No L. FM	No L.	5.10	6.10
Mon.	7	No L.	No L.	5.10	6.10
Tue.	8	6.00 PM	8.40 PM	5.10	6.10
Wed.	9	6.00	9.50	5.10	6.10
Thu.	10	6.00	11.00	5.10	6.10
Fri.	11	6.00	12.10 AM	5.10	6.10
Sat.	12	6.00	1.20	5.20	5.55
Sun.	13	6.10 LQ	2.30	5.20	5.55
Mon.	14	6.10	3.40	5.20	5.55
Tue.	15	6.10	4.40	5.20	5.55
Wed.	16	6.10	5.40	5.20	5.55
Thu.	17	6.10	5.50	5.20	5.55
Fri.	18	6.10	5.50	5.20	5.55
Sat.	19	6.10	5.50	5.30	5.55
Sun.	20	6.20 NM	5.40	5.30	5.55
Mon.	21	6.20	5.40	5.30	5.55
Tue.	22	6.20	5.40	5.30	5.55
Wed.	23	6.20	5.40	5.30	5.55
Thu.	24	6.20	5.40	5.30	5.55
Fri.	25	10.20	5.40	5.30	5.55
Sat.	26	11.20	5.40	5.30	5.45
Sun.	27	12.20 AM FQ	5.30	5.30	5.45
Mon.	28	1.10	5.30	5.30	5.45

TOTAL HOURS LIGHTING DURING 1898.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	210.40	January	423.20
February	186.40	February	355.25
March	181.20	March	355.35
April	166.10	April	298.50
May	156.40	May	264.50
June	144.30	June	234.25
July	147.30	July	243.45
August	157.10	August	280.25
September	169.50	September	321.15
October	186.00	October	374.30
November	204.30	November	401.40
December	218.30	December	433.45
Total, yr.	2129.30	Total, yr.	3987.45







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THE WELSBACH LIGHT COMPANY will pay $500.00 reward for the arrest and conviction of any person representing and selling incandescent burners or mantles as genuine "Welsbachs" that do not bear our trade-mark.

All genuine Welsbach lights have stamped on the brass work "Welsbach System, Patented," and all genuine Welsbach mantles are branded with our trade-mark, "J," and both burners and mantles are sold in boxes bearing our trade name, "Welsbach."

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DOUBLE-SUPERHEATER LOWE WATER GAS APPARATUS.

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Total Daily Capacity, 128,825,000 Cu. Ft.

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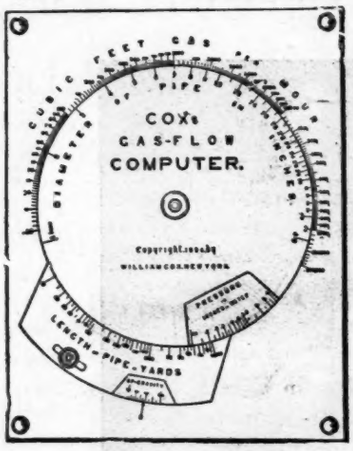

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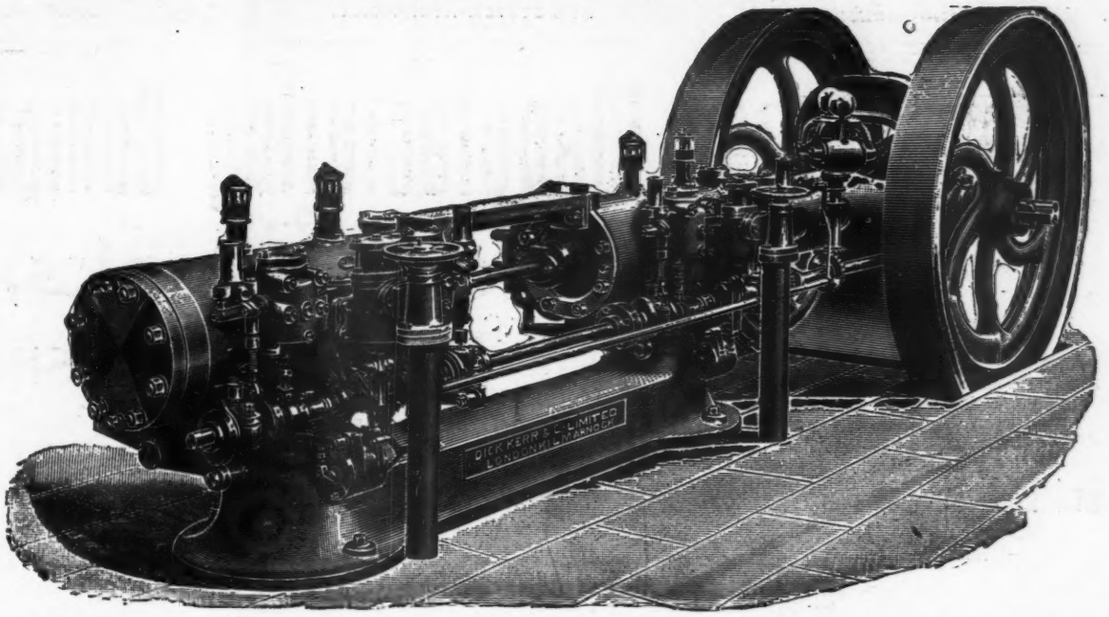

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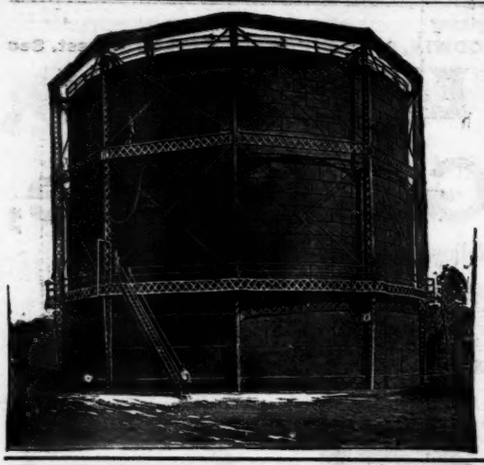

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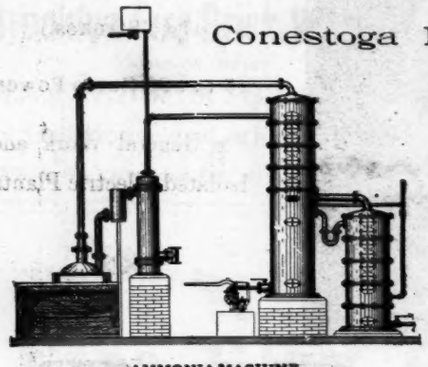

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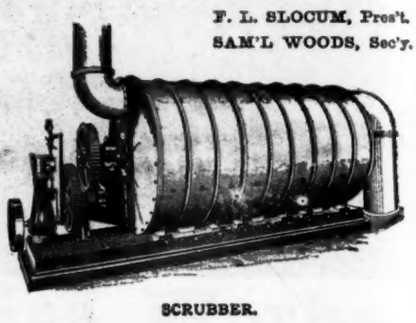

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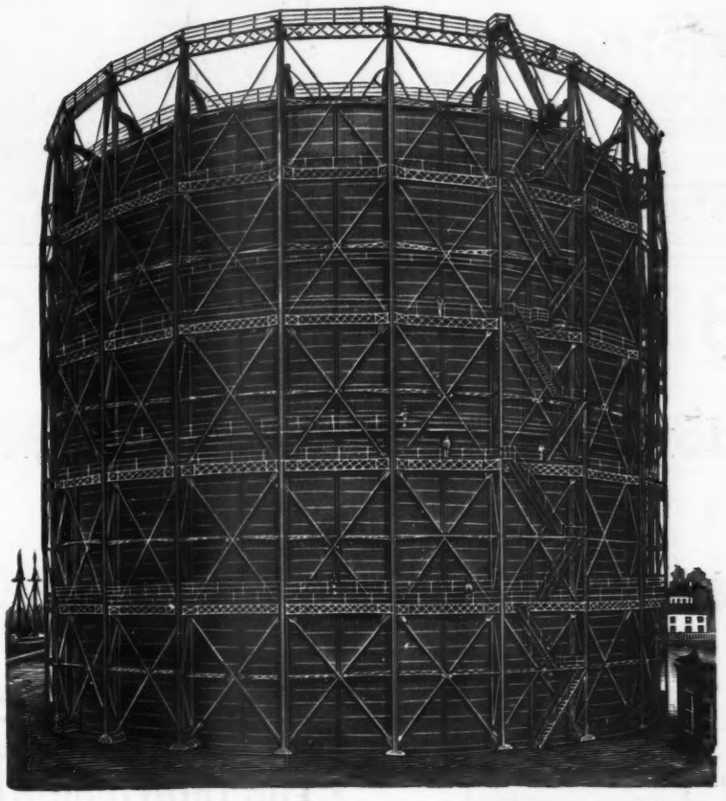

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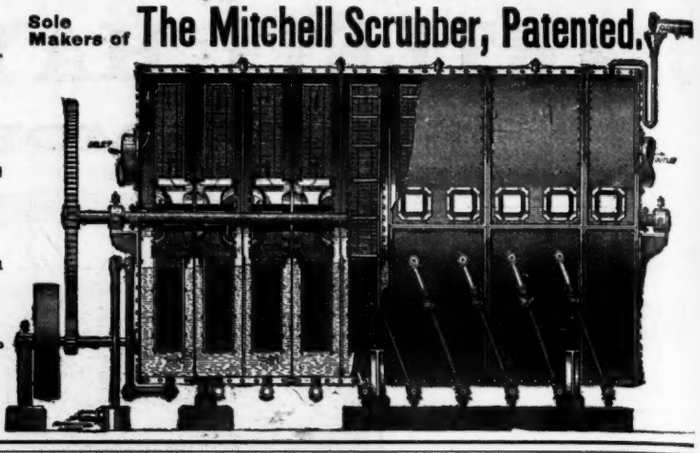

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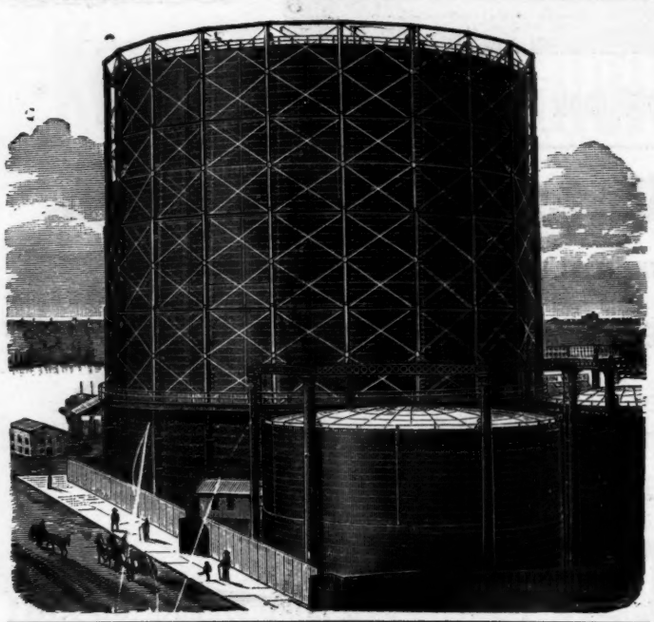

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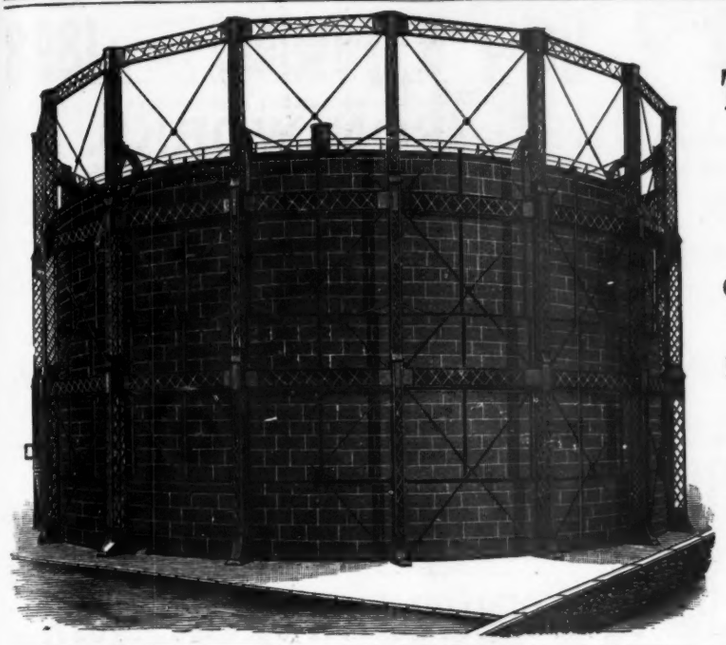

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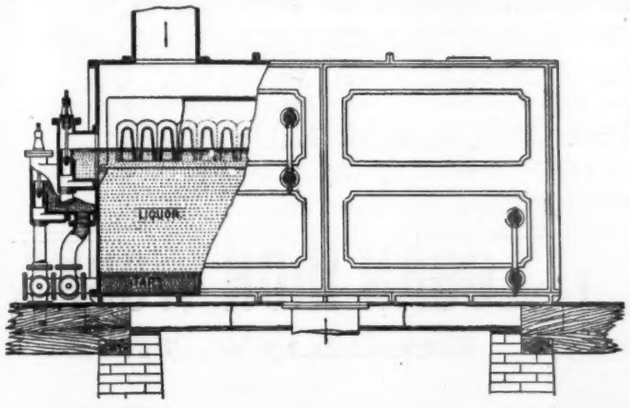

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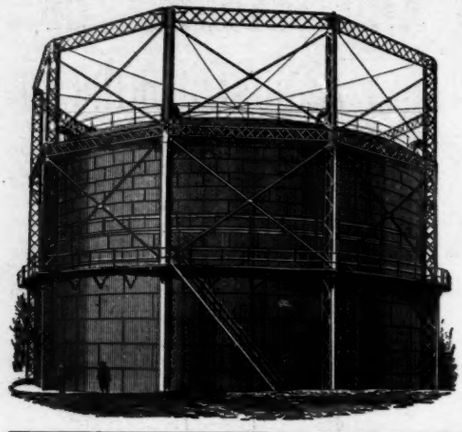

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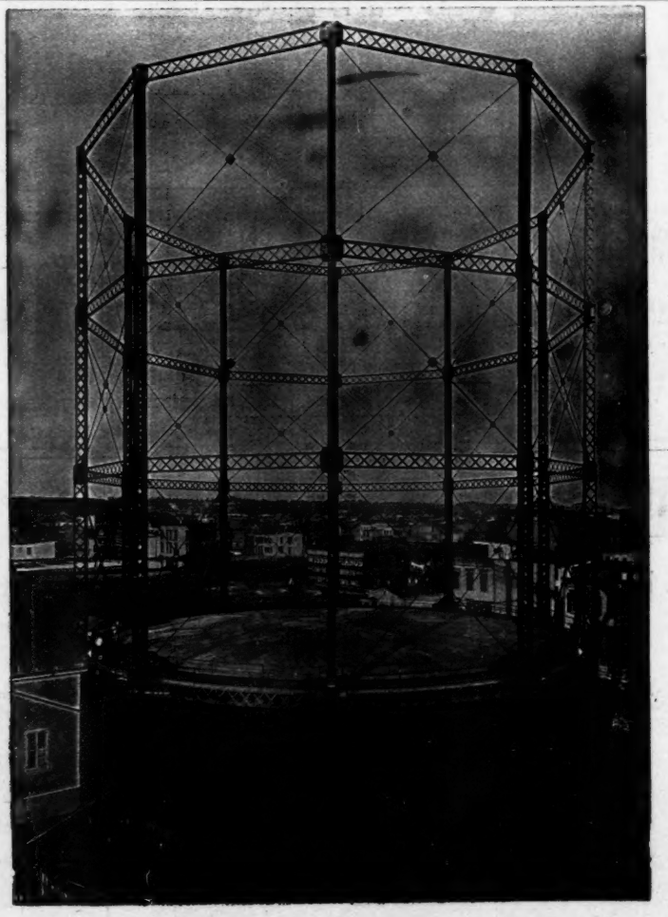

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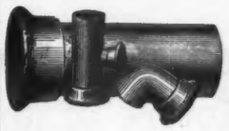

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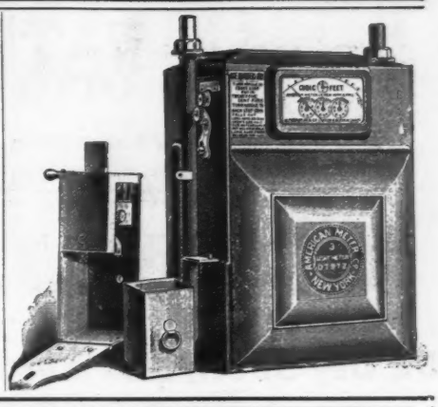

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